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POSSIBLE IMPROVEMENTS FOR ONFARM IRRIGATION SYSTEMS TO REDUCE SALINITY

DRAFT REPORT OF THE
McELMO CREEK
SALINITY CONTROL STUDY

MONTEZUMA COUNTY, COLORADO

COLORADO RIVER BASIN
SALINITY CONTROL PROGRAM

Prepared By
Soil Conservation Service
Assisted By
Agricultural Stabilization and Conservation Service
and
Agricultural Research Service
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United States Department of Agriculture

Denver, Colorado
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I. SUMMARY

This USDA salinity control study was carried out under Public Law 93-320, the Colorado River Basin Salinity Control Act (88 Stat. 266), dated June 24, 1974. Section 201(c) of the Act directs the Secretary of the Interior, the Administrator of the Environmental Protection Agency, and the Secretary of Agriculture to cooperate and coordinate their activities effectively to carry out objectives of Title II of the Act as the basin states continue developing their compact apportioned water. The McElmo Creek Unit, known locally as the Montezuma Valley, is one of five diffuse source control units designated in the Act for expeditious completion of a planning report as a means to implement the salinity control policy adopted for the Colorado River.

The USDA has two primary purposes in the McElmo Creek study: (1) to determine the contribution of salt loading from the irrigated farm land; and (2) to determine the opportunity for reducing salt loading through improvements in irrigation systems and practices.

The scope of the study was limited to inventorying and analyzing current irrigation systems and practices on a sample of the irrigated land and off-farm laterals. Results of these analyses were expanded to be representative of the approximately 29,100 acres of irrigated land and about 235 miles of off-farm laterals in the Montezuma Valley. Canals in the Montezuma Valley Irrigation Company's distribution system are being evaluated by the Bureau of Reclamation and were not studied by USDA. Results of investigation were discussed at joint meetings throughout the study where areas of common concern were identified and issues were resolved.

Coordination of study activities leading to analysis of the salt loading problem in the McElmo Creek Unit was accomplished through a Multi-Objective Planning Team under leadership of the Bureau of Reclamation. Participants in this team effort included personnel from the Bureau of Reclamation, Soil Conservation Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, Colorado Division of Wildlife, Colorado Water Conservation Board, Colorado Department of Health and the Dolores Soil Conservation District.

Mancos shale, a marine formation with high salt content, underlies much of the valley (See Figure III-2) and is the principal source of salt in the McElmo Creek Unit. Lenses of crystalline salt often are exposed during excavation into shale. Because of the arid climate salts have not been leached naturally and applying irrigation water to the soil greatly accelerates the leaching process.

The McElmo Creek contributes about 115,000 tons of salt annually to the Colorado River. About 54,000 tons are attributed to the onfarm portion of current irrigated agriculture which was first introduced into the valley about 70 years ago. Most of the salt is leached from the soil and underlying Mancos shale and carried to the river by deep percolation from irrigation and by seepage from earthen ditches.

Improved management of irrigation water including devices for measuring water onto the fields and lining onfarm and off-farm ditches has the potential for reducing the river's salt load by as much as 32,000 tons, annually reducing salinity concentration of the Colorado River at Imperial Dam by 3.6 milligrams per liter. These impacts are based on the assumption that improvements will be made on about 70 percent of the irrigated area. The remaining irrigated land may not be improved under voluntary participation in the salinity control program because of land use changes or other reasons of the individual land owners.

TABLE I-1 SUMMARY OF ANNUAL SALT LOADING AND POTENTIAL REDUCTION ATTRIBUTED TO IRRIGATED AGRICULTURE.
McELMO CREEK SALINITY CONTROL STUDY, COLORADO.

Source of Loading	Present	Plan Number					
		1	2 1/	3	4	5	6
	tons						
Group Ditches	8000	9000	8000	0	0	0	0
OnFarm Ditches	14000	15000	15000	14000	3000	2000	0
Deep Percolation 2/3/	32000	36000	24000	22000	20000	20000	33000
Totals	54000	60000	47000	36000	23000	22000	33000
Potential for Reduction							
Group Ditches	---	-1000	0	8000	8000	8000	8000
OnFarm Ditches	---	-1000	-1000	0	11000	12000	14000
Deep Percolation	---	-4000	8000	10000	12000	12000	-1000
Sub-Total 4/	---	-6000	7000	18000	31000	32000	21000
Potential for Prevention							
Irrigation Water Management	---	---	6000	6000	6000	6000	0
Total Salt Reduction	---	-6000	13000	24000	37000	38000	21000

1/Plan 2 is the Management Only Plan and will have little effect on reducing salt loading from ditch seepage. The plans are further described in section 5.
2/The present case and Plans 1 and 2 include 5,000 tons/year from Navajo Wash, a separate tributary to the San Juan River.
3/Plans 3, 4 and 5 include about 2,000 tons/year from Navajo Wash.
4/Reduced salt load going to the Colorado River. Plans 2 through 5 will have an additional 6,000 ton prevention benefit due to management of supplemental irrigation water available from the Dolores Project.

Local benefits resulting from these improvements will be reflected in reduced costs of production, improved irrigation systems and increased crop yields. However, these improvements also may adversely impact the 11,000 acres of wetland that have developed as a result of introducing irrigation into the valley.

TABLE I-2 SUMMARY OF ALTERNATIVE PLANS 4/
McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Plan Description	Action	Total Cost 2/ (——$1,000	Annual Net 3/ Benefit ——)	Area Treated: Surface Systems (ac.)	Area Treated: Sprinkler Systems (ac.)	Annual Salt Reduction (tons)	Average Annual Cost ($1,000/mg)
1. Continuation of Ongoing Programs	Onfarm	5/		-		-5,000	
	Off-Farm	5/		-		-1,000	
	Total	795		28,450	0	-6,000	—
2. Irrigation Water 1/ Management	Onfarm	5,538		-		7,000	689
	Off-Farm	0		-		0	0
	Total	5,538	854	20,900	0	7,000	689
3. Irrigation Water Management With Limited Sprinklers	Onfarm	6,187		-		10,000	539
	Off-Farm	7,363		-		8,000	801
	Total	13,550	829	20,900	650	18,000 6/	655
4. Irrigation Water Management With Gravity Sprinklers	Onfarm	18,719		-		23,000	709
	Off-Farm	7,363		-		8,000	801
	Total	26,082	1,153	10,650	10,400	31,000 6/	733
5. Irrigation Water Management With Sprinklers	Onfarm	20,619		-		24,000	748
	Off-Farm	7,363		-		8,000	801
	Total	27,982	1,251	1,850	19,700	32,000 6/	761
6. Ditch Lining Only	Onfarm	12,113		-		13,000	811
	Off-Farm	7,363		-		8,000	801
	Total	19,476	209	28,450	0	21,000	807

— Recommended

1/ Off-Farm improvements are not included with this program emphasizing onfarm irrigation water management only.
2/ July 1981 Price Base.
3/ Costs amortized at 7 5/8 percent interest over 25 years.
4/ Benefits and costs computed in present value terms using six year installation period.
5/ Total Cost was not disaggregated into onfarm and off-farm components.
6/ Does not include the potential 6,000 ton annual salt load anticipated from future irrigation with Dolores Project water that would enter the rive if onfarm salinity control measures are not implemented.

This report describes six candidate plans that address four concepts for reducing the river's salt load. These concepts are: a continuation of ongoing programs (no accelerated action alternative), onfarm irrigation water management (non-structural alternative), ditch lining only, and combining onfarm irrigation water management with ditch lining.

Plan 5 is recommended for implementation. The implementation period should be six years and program effectiveness should be evaluated at three-year intervals to determine if the program is achieving the expected degree of salinity reduction.

TABLE I-3 ESTIMATED QUANTITIES AND COST FOR
IMPLEMENTING THE RECOMMENDED PLAN
McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Item	Units	Quantities	Cost
Pipeline:			
Group Ditches	mi.	235	6,136,000
OnFarm Ditches	mi.	33	893,000
Measuring Devices	ea.	400	408,000
Sprinkler Systems			
Gravity Pressure	ac.	10,000	8,101,000
Pumped Pressure	ac.	9,300	7,784,000
TOTAL COST	$		23,322,000

Implementation of Plan 5 will reduce salt loading in the Colorado River by 32,000 tons per year. The total installation cost is estimated to be $27,986,000. It is recommended that the federal government share the construction cost at a rate not greater than 75 percent. At 75 percent cost-share the cost to the federal government is $22,154,000 over the six-year implementation period, consisting of $17,490,000 for construction and $4,664,000 for administrative and technical assistance. Annual levels of funding needed throughout the implementation period are shown in Table I-4. The total cost to the local people is estimated to be $5,830,500 for construction and $184,300 per year for operation, maintenance and replacement following program implementation.

TABLE I-4 ANNUAL LEVELS OF FUNDING FOR IMPLEMENTATION
McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Year	Construction Federal	Construction Local	Admin. & 1/ Technical Assistance	Local O&M 2/	Total Federal	Total Local	Total Cost
	-------	------	-----------	---$1,000	--------	---------	----
1	2,915	972	972	30.7	3,887	1,002.7	4,889.7
2	2,915	972	972	61.4	3,887	1,033.4	4,920.4
3	2,915	972	972	92.1	3,887	1,064.1	4,951.1
4	2,915	972	973	122.8	3,888	1,094.8	4,982.8
5	2,915	972	973	153.5	3,888	1,125.5	5,013.5
6	2,915	972	973	184.2	3,888	1,156.2	5,044.2
TOTAL	17,490	5,832	5,835	644.7	23,325	6,476.7	29,801.7

1/ Includes $295,000 annually to continue the following: $100,000 for an Irrigation Research Program by ARS, USDA; $45,000 for an Information and Education Program by ES, USDA: and $150,000 for Monitoring and Evaluating Results by SCS, USDA.
2/ Annual level of funding for O&M during implementation period. Following Implementation Annual O&M Cost will remain at about $185,000

IMPLEMENTATION AUTHORITIES

There are three primary USDA authorities through which onfarm improvements might be implemented. These are:

1. The Soil Conservation Act of 1935 (PL 46 - 74th Congress)

Under this authority and working mainly through local soil conservation districts, the Soil Conservation Service (SCS) helps individuals, groups, municipal and county officials, and planning bodies to cope with problems of erosion, water supply and disposal, improper land use, flooding and sedimentation. Assistance rendered by SCS ranges from advice and consultation to on-site technical assistance for preparing conservation plans; determining where conservation practices are practical and necessary; designing, laying out, and supervising installation of the practices; and

checking and certifying performance of the practices. Through the Agricultural Stabilization and Conservation Service and the Agricultural Conservation Program, USDA shares with the land users the cost of applying certain soil and water conservation measures that emphasize conservation benefits of national concern.

2. <u>Federal Water Pollution Control Act (PL 92-500, as amended by Sec. 35 of the Clean Water Act -- PL 95-217)</u>

Under this authority the Rural Clean Water Program helps to control agricultural nonpoint sources of pollution. The Rural Clean Water Program, a voluntary program for applying best management practices on privately owned rural land in eligible project areas, is designed to reduce agricultural pollutants thus improving water quality in rural areas to meet water quality standards or goals. The program provides financial and technical assistance to private landowners and operators. Financial assistance is limited to 50 percent of the cost of applying Best Management Practices with a maximum federal cost-share of $50,000 per participant.

3. <u>The Watershed Protection and Flood Prevention Act (PL 566 - 83rd Congress)</u>

This Act authorizes a program by which USDA provides technical and financial assistance to local watershed groups willing to assume responsibility for initiating, carrying out and sharing the costs of projects for upstream watershed protection, irrigation water management or flood control. Technical assistance includes helping to plan and install project measures.

Recommendations for Implementation

The implementation program needed to significantly reduce salt loading requires accelerated application of conservation practices pertinent to salinity control and the cooperative effort of federal, state and local agencies, and private organizations. To achieve full potential reduction, two conditions must be satisfied. First, recommended irrigation water management practices must be followed to a high degree of precision; and, second, all recommended improvements in the irrigation system must be installed.

Nine actions have been identified as being essential to a successful implementation program. These are:

1. Authorize a continuing level of federal funding that provides incentive for voluntary and continued participation of the farm operators to achieve early completion of the recommended plan to reduce salinity.
2. Establish a local salinity control coordinating committee and follow implementation priorities established by that committee consistent with objectives of the salinity control program so those areas contributing the highest salt load will be treated first.
3. Provide increased technical assistance by SCS through the Dolores Soil Conservation District and by the ASCS county office to service the accelerated work load.
4. Develop a conservation plan for management of complete resource systems including an environmental evaluation for each farm. The conservation plan will identify conservation practices consistent with established priorities for salinity control and will reflect the owner's decisions for making improvements to meet his objectives as well as objectives of the salinity control program.
5. Structure the implementation program so that off-farm group ditches receive improvement ahead of the farms served by those group ditches.

6. Obtain a long-term commitment from farm operators to begin an improvement program based on individual conservation plans and to accelerate that program consistent with established priorities for early completion of improvements needed for salinity control.

7. Continue the program for irrigation research to determine applicability and limitations of various irrigation methods under local conditions of soil, climate, crops and economics.

8. Initiate a program to monitor and evaluate the effectiveness of onfarm improvements to verify that objectives of the salinity control program have been achieved.

9. Initiate an information and education program to disseminate results of research and new developments in irrigation equipment and practices that can aid farmers in practicing good water management for salinity control.

1 - funding levels
2 - local S.C. Coord Comm - priority areas
3 - tech. assistance
4 - Cons. plans per farm
5 - off-farm ditches before on-farm group
6 - long term farmer commitment (LTA)
7 - continue irrigation research
8 - monitor & evaluation
9 - information and educ

II. INTRODUCTION

This section discusses the overall purpose of the study, its scope, the authority by which it was conducted, the coordination between agencies participating in salinity control studies, and the process of plan formulation.

Authority for Investigation

This study was authorized by Public Law 93-320 (88 Stat. 266) dated June 24, 1974, "The Colorado River Basin Salinity Control Act", and was funded under authority of Public Law 83-566, The Watershed Protection and Flood Prevention Act, (68 Stat. 666) enacted in 1954. Section 201(c) of the Salinity Control Act directs the Secretary of the Interior, the Administrator of the Environmental Protection Agency and the Secretary of Agriculture to cooperate and coordinate their activities effectively to carry out objectives of Title II of the Act as the basin states continue developing their compact apportioned waters. The McElmo Creek Unit is one of five diffuse source control units designated in Section 203(a)(1) of the salinity control act for expeditious completion of the planning report as a means to implement the salinity control policy adopted for the Colorado River.

To establish a cooperative program for effective execution of the salinity control act a Memorandum of Understanding, effective November 27, 1974, was entered into between the Bureau of Reclamation and the Soil Conservation Service to implement the specific cooperative activities called for under Title II of the Colorado River Basin Salinity Control Act. On April 10, 1978, the Soil Conservation Service, under authority of Section 6

of Public Law 83-566, initiated feasibility studies of possible improvements in onfarm irrigation systems and practices for the purpose of controlling saline return flows to the Colorado River from McElmo Creek.

Purpose and Objectives

The Colorado River Basin Salinity Control Act firmly establishes that the purpose of salinity control studies is to reduce the salt load carried by the Colorado River. Two co-equal national objectives form the basis for planning. These are to protect and enhance national economic development and to protect and enhance environmental quality. For salinity control studies these two objectives are defined as:

Environmental Quality - Improve water quality by reducing the salt load in the Colorado River while minimizing adverse effects on local fish and wildlife resources.

Economic Development - Enhance agriculture production, and improve local systems and practices for managing irrigation water to reduce salt loading in the river that causes economic damages downstream.

Two overall purposes for participation by USDA in salinity control studies are to: (1) determine the contribution of salt loading from irrigated farm land; and (2) determine the opportunity for reducing salt loading through improvements in irrigation systems and water management practices.

USDA activities include determining the present salt loading and evaluating the existing condition of onfarm irrigation systems and management practices to determine what could be done to improve these conditions and practices to reduce salt loading. These activities were directed toward quantifying answers to three basic questions:

1. What is the magnitude of onfarm improvement needs? Onfarm irrigation improvements include ditch lining or pipelines with appropriate water control structures, onfarm water measuring devices, and irrigation water management.
2. What are the estimated installation costs, the level of funding required for program implementation, and the magnitude of benefits to be derived from implementing needed improvements? Benefits will accrue locally as well as nationally and internationally. Local benefits include reduced costs of production, improved irrigation systems and increased crop yields. National and international benefits accrue through improved quality of water available for downstream users.
3. What will be the effect on salinity contributions to the Colorado River? Salt loading will be reduced through decreasing deep percolation and ditch seepage from irrigation with an increase in irrigation efficiency.

Scope of Study

The scope of the study was limited to inventorying and analyzing current irrigation systems and management practices on a sample of the irrigated land and off-farm laterals. Results of these analyses were expanded to be representative of the approximately 29,100 acres of irrigated land and about 235 miles of laterals in the McElmo Creek Drainage Area. This study does not include analysis of seepage from the canals comprising

Montezuma Valley Irrigation Company's distribution system being evaluated by the Bureau of Reclamation.

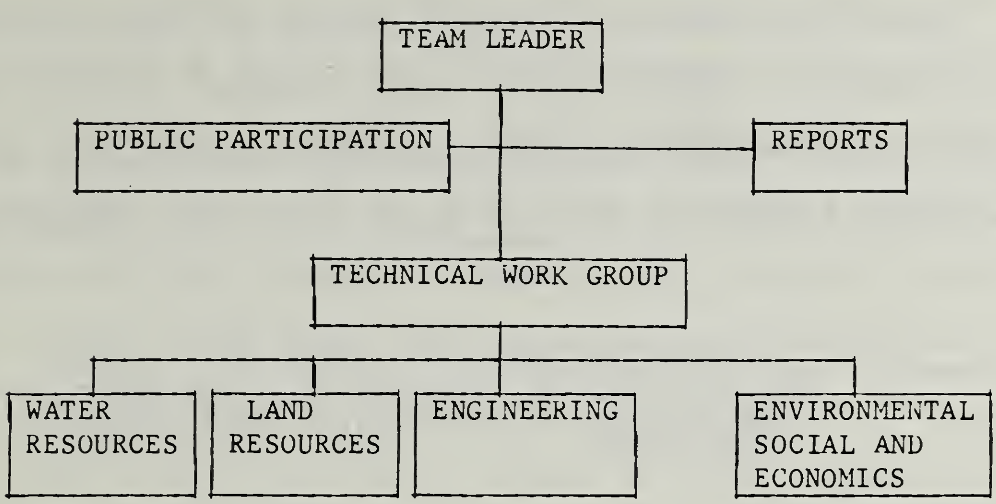
The size of stream in each furrow and the duration of each irrigation were analyzed as the primary managment variables affecting irrigation. Physical improvements in existing irrigation systems were analyzed to determine their effect on water use and the return flows that deliver salt to the Colorado River system. Options for physical improvements consist of ditch lining or gated pipe or pipelines including semi-automated timing devices, and changing to drip or sprinkler methods of irrigation.

Study Coordination

Coordination of study activities leading to analysis of the overall salt loading problem was accomplished through a Multi-Objective Planning Team under leadership of the Bureau of Reclamation (See Figure II-1). The Team directed the activities of several sub-teams comprised of personnel of various disciplines from several agencies of government and other interested organizations. Periodic meetings of the Team were held where progress reports were given, results of investigations by the sub-teams were shared and areas of common concern for the overall study were identified.

Participants in this team effort included personnel from the Bureau of Reclamation, Bureau of Land Management, Soil Conservation Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, Colorado Division of Wildlife, Colorado Water Conservation Board, Colorado Department of Health and the Dolores County Soil Conservation District.

FIGURE II-1 MULTI-OBJECTIVE PLANNING TEAM
McELMO CREEK SALINITY CONTROL STUDY, COLORADO



Irrigation Management Scheduling

A basic assumption in irrigation water management is that the maximum amount of soil moisture to be replaced is relatively fixed for each irrigation depending on allowable moisture depletion for the soil and the crop. However, frequency of irrigation, varying throughout the season and depending on meteorological conditions affecting daily water requirements for each crop, was not a consideration in plan formulation. Therefore, irrigation scheduling will be a useful addition to the onfarm salinity control program. By comparing crop consumptive use requirements and soil moisture depletion rates over short intervals scheduling projects the time for the next irrigation to prevent stress in the crop. Scheduling also recommends the amount of water needed to replenish soil moisture, along with the time of irrigation set to apply the needed amount of water.

Description of Plan Formulation

Onfarm salt loading is caused by seepage and deep percolation of irrigation water into and through saline aquifers. Practices that can reduce seepage and deep percolation and the associated salt load are summarized in Table II-1 and form the basis for plan formulation.

TABLE II-1 SOURCE OF ONFARM SALT LOADING
AND PRACTICES FOR ATTAINING SALT LOAD REDUCTION.
McELMO CREEK SALINITY CONTROL STUDY, COLORADO

CAUSE	APPLICABLE PRACTICES	
	MANAGEMENT	STRUCTURAL
Seepage: Onfarm ditches	Adjust the time of set, number and frequency of irrigations.	Install ditch lining or pipelines and appurtenant structures.
Tailwater Runoff	Adjust the flow rate, the time of set, the number and frequency of irrigations. Change to more efficient method of irrigation.	Install lined and unlined tailwater collection ditches or lined ponds.
Deep percolation and non-uniform application of irrigation water	Adjust the number of irrigations, the time of set, and flow rate. Change to more efficient method of irrigation.	Install water measuring devices, land smoothing, and automated timing devices. Change to border, drip or sprinkler methods of irrigation.
Inefficient layout of fields and irrigation systems.	Combine fields or change to more efficent method of irrigation.	Close existing open drains. Relocate pipelines and ditches. Change to border, drip or sprinkler methods of irrigation.

The undulating topography, ranging between 2 to 12 percent land slopes, essentially precludes attaining uniform application of irrigation water using surface methods of application in much of the Montezuma Valley. Without uniformity of application a primary element of irrigation water management is lacking. Sprinkler irrigation systems, easily operable under local topographic conditions, are well suited to achieving uniform distribution and other aspects of irrigation water management needed for salinity control. Land slopes offer opportunity to develop gravity pressure needed to effectively operate sprinklers on 10,400 acres of land; and the pipelines used to carry water under pressure to the sprinklers will essentially eliminate seepage from that portion of the existing water delivery system. Therefore, sprinkler irrigation systems are a primary element of plan formulation supplementing irrigation water management as the non-structural means for salinity control.

Incremental units of development used in plan formulation are:

1. Continuation of Ongoing Programs - the no accelerated action program.
2. Irrigation Water Management - the non-structural program.
3. Irrigation Water Management with limited use of sprinklers.
4. Irrigation Water Management and extensive use of sprinklers using only gravity pressure.
5. Irrigation Water Management and extensive use of sprinklers using gravity and pumped pressure
6. Ditch lining only.

It should be noted that there is a low likelihood of achieving the indicated degree of potential salt load reduction attributed to irrigation water management. Present onfarm irrigation practices, developed and suited to each farmer's circumstances, experience and perference, are not likely to be changed without some incentive for doing so.

Economic Analysis

Basic data for the economic analysis was obtained through public meetings, questionnaires, and interviews with area residents, Bureau of Reclamation and other federal and state agency personnel. Soil Conseration Service employees, local leaders in the McElmo Creek Study area, research publications and experts in the field were consulted in an attempt to improve the analysis. The economic analysis emphasized the importance of compiling and analyzing the physical data in a manner so the data were sensitive to varying levels of resource development. The analysis was based on comparing effects of the various alternatives with effects of continuing ongoing programs. Water Resources Council's current normalized prices for crops were used. One of the most important aspects of the analysis was determining the effects of continuation of ongoing programs so that each alternative could be judged from that basis. Data estimates for present conditions also were developed.

Onfarm Benefits

Crop budgets were developed for continuation of ongoing programs and for future conditions under each of the alternative plans. Production costs were identified with particular emphasis placed on variable costs. In cases where it was determined that yield levels and/or production costs varied by soil classes, crop budgets were developed accordingly.

The basic physical data indicated that the irrigated soils types could be grouped into three crop yield classes. Each of these soil classes was analyzed for surface and sprinkler methods of irrigation.

Budgets were developed for three crop yeild classes and the five major crops which include over 95 percent of all crops inventoried.

Types of benefits measured on the crop budgets were irrigation labor cost savings, operation and maintenance cost savings, energy and fuel cost savings, machinery labor cost savings, fertilizer cost savings, and crop yield changes. Data were then analyzed according to the number of acres of each class of soil.

Downstream Benefits

The downstream benefit figure indexed to September 1981 1/, using the Gross National Product Implicit Price Deflator factors, is $490,000 in average annual benefits for each miligram per liter (mg/l) decrease in salinity concentration of the Colorado River at Imperial Dam. The $490,000 converts to $51.00 of average annual benefits per ton of salt reduction that was used in the economic analysis to obtain downstream benefits by watershed.

Other Benefits

Other benefits regional in nature accruing because of the works of improvement are employment benefits and externalities. Employment benefits accrue through employment of otherwise unemployed or underemployed labor resources during installation.

1/ The Gross National Product Implicit Price Deflator factors were used to update economic impacts from the study by Kleinman and Brown of the Bureau of Reclamation, published in 1980. ($343,000 per mg/l, 1976 dollars).

Externalities include two types of benefits: the first type "stems from" program implementation and the second type is "induced by" the program. Benefits that "stem from" implementation arise from increased production of goods afforded by the improvement program. With this increased supply of goods, new demands are placed upon local transporting, processing and marketing industries. Benefits "induced by" implementation arise from increased expenditures by the local people. These benefits result from supplying additional materials and services required to make possible the increased net returns resulting from installation of the improvements.

Principles and Standards

The Principles and Standards Account Tables illustrating the National Economic Development, Environmental Quality, Regional Development, and Other Social Effects for each alternative plan are shown in the Appendix.

III SETTING

Location

The McElmo Creek Salinity Control Unit, known locally as the Montezuma Valley, is located within Montezuma County in the southwest corner of Colorado. It lies between prominent physiographic features such as Mesa Verde rising to an elevation of about 8,400 feet on the southeast, Ute Mountain rising about 10,000 feet on the southwest, and the Dolores River Canyon to the northeast. North and northwest of Cortez the land is a high

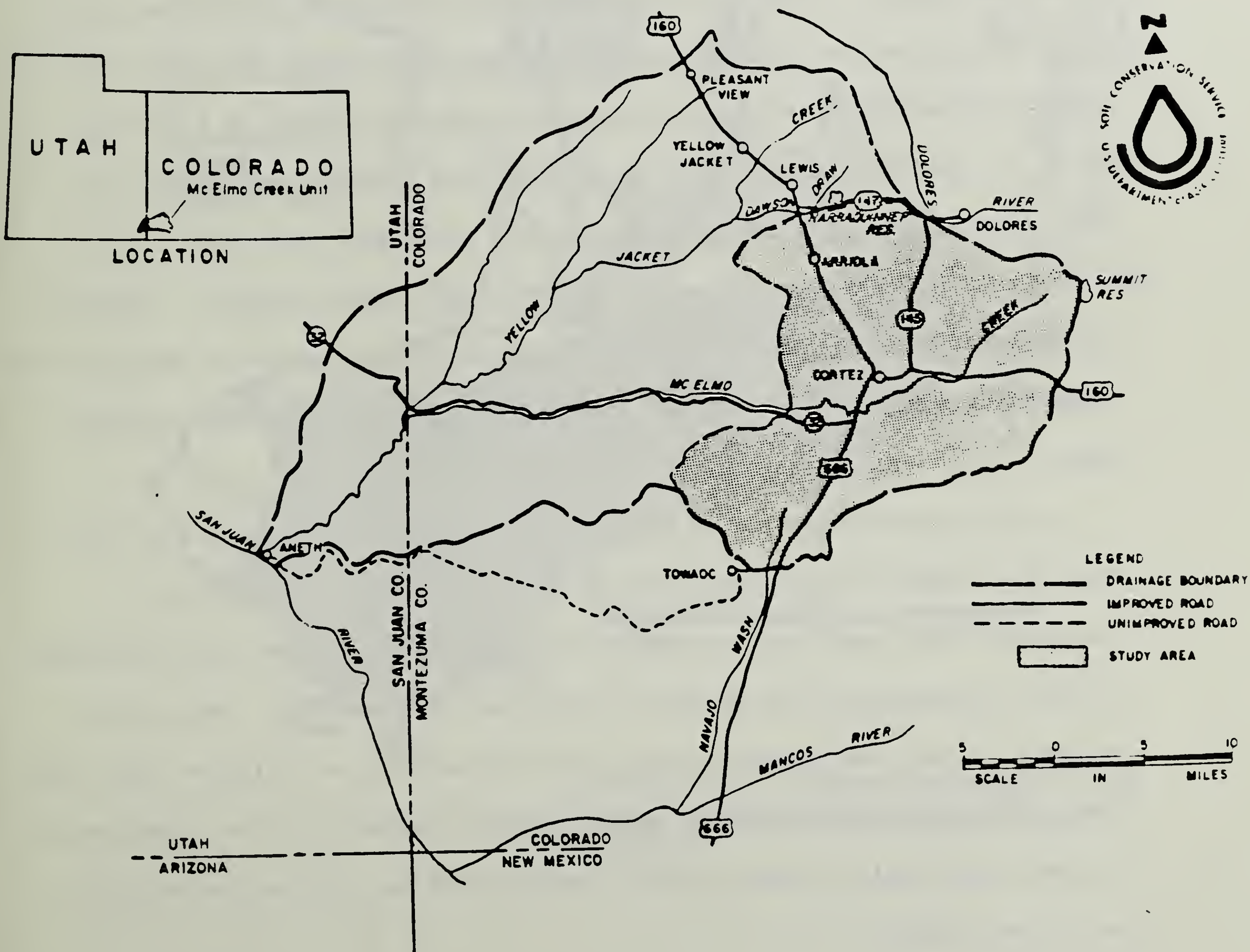


FIGURE III-1. McELMO CREEK DRAINAGE.
McELMO CREEK SALINITY CONTROL STUDY, COLORADO.

rolling plain with gently sloping hills, dissecting streams and occasional steep-walled canyons. The elevation at Cortez is about 6,030 feet above mean sea level.

Geology

Shale of the Mancos Formation underlies much of the Montezuma Valley. To the north and west, the valley is bordered by outcrop areas of sandstone of the Dakota Formation and sandstone and shale of other older sedimentary formations as well as small areas of younger volcanic rocks as shown in Figure III-2. The Mancos Formation consists mainly of gray silty clay shale of marine origin. It is the principal source of salt in the McElmo Creek area. The salts are concentrated in certain areas within the shale and the younger shale-derived alluvial deposits, usually at depths of a few feet below the ground surface in the lower more arid portions of the valley. Here, natural infiltration of precipitation and runoff water was not sufficient to leach the salts from the soil and bedrock profile. However, the application of irrigation water has increased the amount of water moving through the soil profile and has greatly increased salt loading in McElmo Creek.

Another smaller source of salt in the area is concentrations of salt associated with the coal bed lying in the upper part of the Dakota Formation. This coal bed is overlain by several feet of resistant sandstone and only infrequently can be seen in outcrops or road cuts. Where this sequence of coal and sandstone lies near the surface in irrigated areas, the slow infiltration of irrigation water through fractures in the sandstone and the coal bed results in the gradual leaching and the delivery of salts to the stream system.

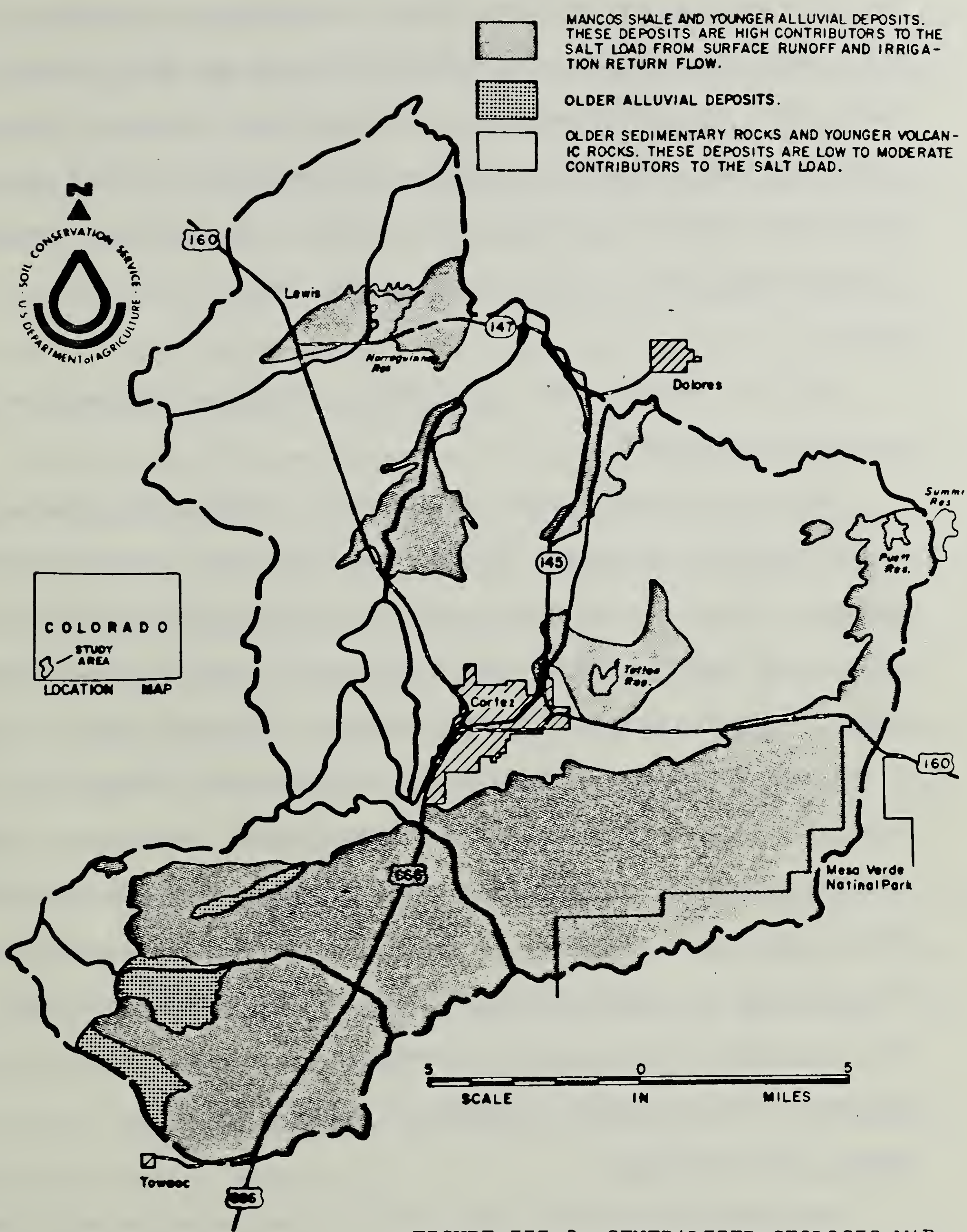


FIGURE III-2 GENERALIZED GEOLOGIC MAP.
McELMO CREEK SALINITY CONTROL STUDY, COLORADO.

In most of the area underlain by the Mancos Formation, ground water moves generally downward through permeable sandy alluvium or fractured shale to a firm shale layer and then laterally discharging into the stream system along major drainageways. In areas underlain by the Dakota Formation and older rocks, the ground water moves through the fractures in the sandstone layers and mostly discharges into the major streams. A small part of the ground water moves very slowly down the dip of the sandstone (mainly southeastward) into the San Juan structural basin.

Soils

Soils in the Montezuma Valley follow the pattern of geologic materials shown in Figure III-2.

Soils in the southern part of the valley originated predominantly from marine shales and sandstone, giving their gray color, medium to fine (silty) textures with good water intake rates and moderately high salt content. The soils of the higher alluvial fans are generally shallow (3 to 4 feet) above cobble, while the flood plain soils generally extend to depths of 20 feet. In the northern part of the valley the windblown soil deposits are loam to light clay loam in texture, with good water intake rates and no salinity or alkalinity problems. These soils range from deep, well drained deposits to shallow soils over sandstones at 10-20 inch depth. The irrigated area is characterized by rolling topography with slopes of up to 12 percent. Less than 10 percent of the area has slopes under 2 percent. Land in the Montezuma Valley has been irrigated for over 70 years.

History and Archaeology

The Dominguez-Escalante Trail of 1776, designated for study under the provisions of the National Trail System Act of 1976 (Public Law 94-527) to determine eligibility for inclusion in the system, passes through the area. The trail marks an historic 1,800-mile trip by two Franciscan padres, Fray

Francisco Antanasio Dominquez and Fray Silvestre Velez de Escalante, from Sante Fe, New Mexico, northward through western Colorado, across northern Utah, southward through western Utah, and across Arizona back to Sante Fe. The expedition was intended to discover an overland route between Spanish missions in Sante Fe, New Mexico and Monterey, California. Although unsuccessful in its objective, the exploration made a major contribution to geographic and cultural knowledge of the Southwest and led to development of the Spanish trails between settlements. There is no physical evidence of the trail itself; its location has been interpreted primarily from a diary kept by Escalante during the Expediton.1/

Big Bend, the first settlement on the Dolores River is another site of local historical interest. Established in about 1880 it was 2 miles west of the present town of Dolores. The town was named for its location on a broad plain where the river changes its course from west to north. Containing a bank, a blacksmith shop, stores, and other businesses, the town was the population and commercial center of the area until 1891 when the Denver and Rio Grande Railroad entered the Dolores River Valley going upstream to the mining town of Rico. The present town of Dolores was laid out where the railroad entered the valley, and several buildings, businesses, and the post office were moved from Big Bend to the new townsite. Eventually the town was removed, the land was cultivated, and now is used as pastureland. The State Historic Preservation Office has evaluated the old town site, concluding that it does not meet criteria for eligibility to the National Register of Historic Places. 2/

1/ Bolton, Herbert E., 1972, Pageant in the Wilderness: The Story of the Excalante Expedition to the Interior Basin, 1776 Utah State Historical Society, pp. 29-33.
2/ Correspondence from the State Historcial Society of Colorado to the Bureau of Reclamation dated July 7, October 7, and November 21, 1975.

The Four Corners Region - southwest Colorado, southeast Utah, northeast Arizona and northwest New Mexico - is rich in the Indian ruins and sites of the Anasazi ("Old Ones"). The University of Colorado, working under contract for the Bureau of Reclamation, inventoried 592 sites. The sites vary in extent with surface indications including rock chips, pottery, pithouses, and remains of pueblos and other structures representing past occupation of the area from perhaps 2500 B.C. until recent historic times. Relatively little work has been done previously and information on prehistoric habitation is meager.

In addition, six sites presumed to be of recent historical age were found, consisting primarily of Ute or Navajo Indian sweat lodges.

Six properties containing Anasazi ruins are listed on the National Register of Historic Places: Escalante Ruins (recently restored and now managed for the public by the Bureau of Land Management), Mesa Verde National Park, Ute Mountain Mancos Canyon Historic District, Yucca House National Monument, Hovenweep National Monument, and Lowry Ruin 2/. Program actions will not affect any known sites.

Climate

The climate is semiarid, characterized by low precipitation, low humidity, abundant sunshine, a fairly large range in daily and seasonal temperatures, and moderate westerly winds. Elevation changes cause large variations in the local climate within short distances, with increases in precipitation and decreases in temperature from southwest to northeast.

2/ Federal Register, Vol. 41, No. 28 (February 10, 1976), and all monthly supplements.

Average annual precipitation ranges from less than 10 inches in the southwestern corner of the area to about 20 inches in the northeast. Precipitation varies considerably from year to year but on the average June is the driest part of the year and July through October is the wettest. Afternoon showers commonly occur during July through mid-September occasionally reaching thunderstorm intensity. Damaging storms and other severe weather conditions are infrequent.

Typically clear skies and high solar radiation, combined with the elevation of the area, result in warm days and cool nights during the spring, summer, and fall. The days also are comfortably warm during the winter but the nights are cold. Maximum daytime temperatures vary from about 32-40°F. in January to 80-90°F. in July, with corresponding nighttime minimums ranging from nearly 0°F. to around 50°F. Temperatures of over 100°F. have been recorded twice in Cortez, and extreme low temperatures have dropped below -25°F. The frost-free period varies between 130 to 140 days in the Montezuma Valley.

Water Resources

The Dolores River, originating in the La Plata and San Miguel Mountains to the northeast and flowing along the northeastern edge of the Montezuma Valley, is the major source of water diverted into and used in the area. Tributaries of the San Juan River drain the area.

Montezuma Valley Irrigation Company, the major user and distributor of Dolores River water, possesses absolute diversion right for 707.7 cubic feet per second (cfs) to irrigate 46,000 acres of land, a conditional right for 592.3 cfs to irrigate an additional 38,500 acres, and a right for the year-round use of 100 cfs for stock, domestic, and industrial purposes. The company diverts an average of 116,000 acre-feet annually (1957-73), conveys the water into Montezuma Valley through a tunnel and a main canal, and distributes it to users through an extensive system of canals and laterals. The Montezuma Valley Irrigation Company experiences shortages of about 13 percent of its annual irrigation requirements, usually in the late summer. Completion of the Dolores Project will alleviate this shortage.

The Montezuma Valley Irrigation Company provides storage and regulation at three reservoirs in and near the study area. Groundhog Reservoir is located on Groundhog Creek, a tributary of the West Dolores River, and has a capacity of 21,700 acre-feet. Narraguinnep Reservoir, located about 10 miles north of Cortez, has a capacity of 19,000 acre-feet. Totten Reservoir, to the east of Cortez, has a capacity of 3,000 acre-feet. Both of these reservoirs store water diverted from the Dolores River.

The Summit Reservoir and Irrigation Company, another user of Dolores River water, possesses absolute storage right for 4,088 acre-feet and conditional storage right for another 3,289 acre-feet annually. This water is diverted from the Lost Canyon Creek tributary of the Dolores River, transported to the Puett and Summit reservoirs, and used to irrigate about 4,600 acres of land in the extreme northeast end of the McElmo Creek drainage area.

Municipal and domestic water for the city of Cortez and other users is delivered through the existing Dolores Tunnel under a contract with Montezuma Valley Irrigation Company.

The San Juan River originates in the San Juan Mountains of Colorado, approximately 100 miles east of Cortez. Flowing in a westerly direction through northern New Mexico and the southwestern tip of Colorado the San Juan joins the Colorado River in southern Utah about 100 miles west of Cortez. The study area is drained by San Juan's tributaries, most of which flow only intermittently from spring snowmelt and summer storms. Constant flows are found only in Yellow Jacket Creek and its tributary Dawson Draw, in Navajo Wash, and in McElmo Creek; all heavily dependent upon irrigation return flows. Dawson Draw, originating to the north of Narraguinnep Reservoir, drains the northern tip of irrigated land in Montezuma Valley.

The Mancos River originates in the La Plata Mountains to the east and flows to the southwest, joining the San Juan River near the southwestern corner of Colorado. Although the upper portion of the Mancos River has permanent flows, irrigation diversions frequently deplete the lower portion, which flows only during runoff from melting snow or summer thunderstorms or from Navajo Wash.

Navajo Wash originates to the northeast of Towaoc and flows south for about 15 miles to its confluence with the Mancos. Return flows and canal spills from irrigation in Montezuma Valley provide flows during the summer and fall. The flows are highly variable, often exhibiting large fluctuations during a single day.

McElmo Creek originates in Montezuma Valley between Dawson Draw and Navajo Wash and flows toward the west, joining the San Juan River in southeastern Utah. Return flows from irrigation in the valley and from urban use in Cortez constitute much of the water in the channel.

Ground Water Resources

Ground water resources are limited. Existing wells yield less than 50 gallons per minute in the Montezuma Valley area and less than 10 gallons per minute to the north and south 1/. Depths to ground water vary considerably, from less than 50 feet along stream valleys to more than 500 feet on plateaus and stream divides. The volume of recoverable water in the upper 100 feet of saturated rocks is estimated to be less than 2 acre-feet per acre in the Montezuma Valley area and less than 0.5 acre-foot per acre in surrounding areas.

Water Quality

Immediately below the town of Dolores, the quality of Dolores River water is well within the U.S. Public Health Service and Colorado State drinking water standards. Samples collected by the Bureau of Reclamation from 1953 through 1960 contained total dissolved solids (TDS) in a flow-weighted average concentration of 127 milligrams per liter (mg/l). Depending upon the time of year, the concentrations ranged from 79 to 352 mg/l.

The Colorado State Department of Health collected 36 water samples at Dolores from 1969 through 1975. 2/ Although its analyses inidcated the presence of heavy metals - iron, zinc, and mercury and the toxic substances arsenic and selenium - none of these elements exceeded the recommended limits for domestic water.

1/ Colorado Water Conservation Board and United States Department of Agriculture, Water and Related Land Resources: San Juan River Basin; Arizona, Colorado, New Mexico, and Utah (Denver, June 1974).
2/ Provided by the Air and Water Surveillance and Analysis Division, Environmental Protection Agency, Denver, Colo.

Because of several factors, water quality in McElmo Creek is poor. Studies by the Bureau of Reclamation indicate that return flows from irrigation and the presence of the Mancos shale formation in the drainage area contribute to high salinity concentrations, averaging 2,650 mg/l near Cortez and 2,880 mg/l near the Colorado-Utah State line. The overall quality of the stream varies considerably because of fluctuations in the volume of the return flows. Overall, the water is very saline, and quite hard. The high levels of dissolved salts, turbidity, and temperatures create a harsh environment for fresh water fish and invertebrates. Flow in

Navajo Wash is derived primarily from irrigation return flows during much of the summer and fall, and both the flow and turbidity fluctuate often, even within the same day 1/. The quality of the water is generally poor. Samples collected by the Bureau of Indian Affairs since 1968 have shown salinity concentrations ranging from 6,330 mg/l during low flows to 1,980 mg/l during high flows.

Ground Water Quality

Salinity concentrations of ground water in the Montezuma Valley vary from about 250 to 3,000 mg/l. In the lower elevations of the McElmo Creek area it varies from 1,000 to 3,000 mg/l.

Land Ownership

Irrigated agriculture is well suited to the area with an estimated 29,100 acres of irrigated cropland presently in the study area. The median size of irrigated farm is 85 acres. The average overall per acre value of farmland in Montezuma County is $427 2/, with irrigated cropland ranging from $1,000 to $3,000 per acre. The per farm market value of products sold is $20,533. The number of farms by value of sales are as follows:

1/ Buddy Lee Jensen, Fishery Management Biologist, Dolores Project Investigations: Ute Mountain Indian Reservation, Colorado and New Mexico (U.S. Fish and Wildlife Service: Gallup, N. Mex., January 30, 1975).
2/ Bureau of Census, 1978 Census of Agriculture Colorado, U.S. Department of Commerce.

NUMBER OF FARMS BY VALUE OF SALES

Value		No.
$20,000 and over	-	122
10,000 - 19,989	-	82
5,000 - 9,999	-	113
25,000 - 4,999	-	97
less than 2,500	-	170
TOTAL		584

It is anticipated that crop distribution and yield will change considerably with completion of the Dolores Project as shown in the project plan by the Bureau of Reclamation. Crop distribution is not anticipated to change significantly due to implementation of the McElmo Creek Salinity Control Program. It is anticipated that principal future crops will be pasture and animal feed.

Expansion to accomodate the estimated one percent per year growth in population will encroach on approximately 300 irrigated acres during the next 25 years. This acreage has already been subtracted from the total acreage to arrive at the 28,450 acres of irrigated cropland in the area being considered for program action.

Present and anticipated cropping patterns for the McElmo Creek Salinity Study Area are:

IRRIGATED CROPPING PATTERN

CROP 4/	PRESENT 1/	FUTURE WITHOUT 2/ 1/	FUTURE WITH 3/
Alfalfa and Hay	29.4%	49.3%	50.3%
Small Grains	7.1	13.6	13.6
Pasture	56.9	25.5	24.5
Corn Silage	1.7	5.0	5.0
Dry Beans	0.0	2.5	2.5
Fallow(Idle)	4.1	4.1	4.1
Apples	0.8	0.0	0.0
TOTALS	100.0	100.0	100.0%

1/ Based on field inventory and 1981 Bureau of Reclamation data for the Dolores Project.
2/ Anticipated composite acreage with the Dolores Project in place. Also, the composite acreage for alternative 1 and 6.
3/ Alternative 2,3,4 and 5 composite acreage.

Montezuma County contains 1,341,900 acres, consisting of 375,700 acres of private land, 433,000 acres of Indian Reservation, and 533,200 acres of public land. Most of the National Park Service land lies within Mesa Verde National Park, with small amounts in Yucca House and Hovenweep National Monuments. The 260,200 acres of Forest Service land comprise about 14 percent of the San Juan National Forest in southwestern Colorado, with the bulk of the forest lying to the east. State and local governments, controlling less than one percent of the total area, lease most of their land to farmers and ranchers. The Ute Mountain Indian Reservation, in addition to its 433,000 acres in Montezuma County, includes 107,500 acres in New Mexico and 13,500 acres in Utah.

Land Ownership

Ownership	Acres
Private	375,700
Indian	433,000
Bureau of Land Management	209,300
Forest Service	260,200
National Park Service	51,800
State and local governments	11,900
TOTAL	1,341,900

SOCIAL AND ECONOMIC CHARACTERISTICS 1/

The McElmo Creek Salinity Study area occupies only part of Montezuma County in the southwest corner of Colorado. Montezuma County is one of the least populated counties in the State with 16,510 people in a total of 2,080 square miles (1980 census). The average of 7.9 people per square mile is low compared to the State average of 28. Of the inhabitants 7,095 live in the city of Cortez, with other concentrations in Dolores (802), and Mancos (870), and the Ute Mountain Tribe at Towac (1138).

1/ Advance Reports 1980 Census of Population and Housing, Colorado, Bureau of Census U.S. Department of Commerce, March 1981.

Over the past 50 years Montezuma County has increased from 7,798 to 16,510 people. During this time there have been significant variations in population although the area has remained generally rural.

Initial growth was directly related to mining. Agriculture did not become significant until after 1890, when irrigation water was first delivered to Montezuma Valley. Until 1950, most of the population growth was a result of the expanding agricultural industry. Growth was relatively uniform and gradual until the decade of 1950-60 when oil exploration caused a sharp increase from 9,991 to 14,024 during this 10-year period. Following 1960, oil explorations dwindled and the population declined sharply, although it remained above the 1950 level. Between the years 1960 and 1970, the population in Montezuma county decreased while population in the State increased. However from 1970 to 1980, the population again grew significantly due to renewed oil interest and construction of the Dolores Project.

Population change 1930-1980

Year	Montezuma County	Percent Change	Colorado	Percent Change
1930	7,798	---	1,035,791	---
1940	10,463	34	1,123,296	8
1950	9,991	-5	1,325,089	18
1960	14,024	40	1,753,947	32
1970	12,024	-14	2,209,596	26
1980	16,510	37	2,888,834	31

Indians and Spanish Americans, the largest minority groups, comprise 18 percent of the County population. Approximately 1,651 Indians live in the county; most of them belong to the Ute Mountain Indian Tribe at Towaoc, 11 miles south of Cortez. Of all Indians in the area, 90 percent live in this community which is outside of the McElmo study area. Also, the 1980 census estimated that 1,352 people in the area are of Spanish-American origin, with nearly 55 percent living in the city of Cortez.

The population identified by Race and Origin from advance reports of the 1980 Census is as follows:

Population by Race (1980)

The State Counties County Subdivisions	Total	Race: White	Black	Indian 1/ Eskimo and Aleut	Asian & Pacific Islander	Other	Spanish 2/ Origin
Montezuma County---	16 510	14 219	10	1 651	46	584	1 352
Cortez division---------	11 227	10 344	10	467	34	372	944
Cortez City--------	7 095	6 408	9	332	23	323	734
Dolores division--------	1 865	1 769	-	19	1	76	220
Dolores town-------	802	733	-	5	1	63	142
Mancos division---------	1 785	1 611	-	49	10	115	167
Mancos town--------	870	753	-	17	7	93	114
Pleasant View division--	495	477	-	5	1	12	12
Ute Mountain division---	1 138	18	-	1 111	-	9	9

1/ American Indian.
2/ Included in white totals.

Short term growth in the county has occured from the Dolores project. Little additional growth from implementing the McElmo Creek Salinity Control Program is anticipated. The reduction in construction workers from the Dolores Project will more than offset any slight increase from the Salinity Control Program. Increased housing needs, therefore, should not be a problem and relocation of people is not anticipated.

Long term population projections for the county are estimated to be about one percent per year and growth likely will be from historical growth trends, impacts of program development, expansion of the agriculture and tourist industries, the desirability of the area for retirement, and the continued development of nearby energy resources.

Montezuma County has a work force of about 6,500 persons [3/] including 6000 presently employed. The unemployment rate is 6.9% as compared with 5.2% unemployment for Colorado. Rural areas account for approximately 40% of the population, however, only 510 are presently employed in agriculture.

Employment data later than 1970 are not available on a complete breakdown basis. Retail trade as a whole is the largest employer in the County. Other large employers include health and education, agriculture and construction.

Employment in Montezuma County by Industry [4/]

Industry	Persons Employed
Employment	4,018
Agriculture	510
Mining	206
Construction	399
Manufacturing Total	297
Durable goods	(245)
Nondurable goods	(52)
Transportation	123
Communications	15
Public utilities	65
Wholesale trade	124
Retail trade	885
Finance, insurance, and real estate	134
Services and recreation	363
Health and education	542
Nonprofit organizations	85
Professional services	48
Public administration	327

3/Colorado Department of Labor and Employment, Division of Employment and Training. July 1981.

4/U.S. Bureau of the Census, General Social and Economic Characteristics, Colorado, 1970 Census of Population, U.S. Department of Commerce.

Current estimates indicate a gradual growth in the overall number of jobs in the area. Employment trend estimates perceive the number of jobs in agriculture will increase due to the Dolores Project and the Salinity Control Program. All other sectors are expected to increase also. The top employing sectors are expected to be wholesale-retail trade, services, government, mining and construction.

Wetland and Wildlife Resources

Agricultural land, coniferous forests, drainages, wetlands and brushland combine to provide a high diversity of wildlife habitat in the McElmo Creek Basin. Much of this diversity have been induced by irrigated agriculture, which began in the 1880's. Irrigation converted a xeric basin into a multifarious of habitats, including ponds, marshes, reservoirs, cropland, and those habitats created by the irrigation water conveyance systems - the canals, laterals and ditches.

Three inventories, contracted by the Bureau of Reclamation, serve to identify and quantify the wildlife of McElmo Basin:

Smith, Norwin F. 1979. Aquatic Inventory: McElmo Creek Project, Colorado. Colorado Division of Wildlife. 92 pp.

Burdick, Harold E. 1979. Wildlife Inventory: McElmo Creek Project. Colorado Division of Wildlife. 35 pp.

Somers, Preston. 1979. Inventory of Terrestrial Nongame Animals of the McElmo Creek Unit Area, Colorado River Basin Salinity Control Project, Colorado. Fort Lewis College. 113 pp.

Smith indicated that McElmo Creek, which is fed by irrigation return flows and proceeds westward for 36 miles to its confluence with the San Juan River, has extremely poor water quality with high salinity and turbidity conditions. Biomass of fish taken during the inventory indicated 1.9 pounds of game fish per acre (channel catfish and green sunfish) and 12.9 pounds of non-game fish per acre (carp, suckers and various minnows).

The aquatic inventory conducted surveys on 45 tributaries to McElmo Creek. These tributaries are typically dry or almost so during the winter months. Only speckled dace and fathead minnows were collected from them.

No fishery exists in the streams, and the available sports fishery in the area is supplied primarily by 5 reservoirs managed by the Colorado Division of Wildlife. These are: Denny Lake, Narraguinnep, Puett, Summit and Toten reservoirs. Numerous small ponds are located within the study area also.

Burdick's study addressed those wildlife species generally classified as economic or those associated with sport hunting or trapping.

The following are those species inventories by Burdick (Table III-1). Habitats on which the onfarm portion of this study will have the greatest potential impact are riparian and wetlands as associated with irrigation, and, to a lesser degree, cropland.

Table III-1. Relative Abundance of Wildlife by Habitat Type

Species	Inventory Method	SEMI-DESERT	RIPARIAN	CROPLAND	SAGE BRUSH	PINYON-JUNIPER	PONDEROSA PINE	OAKBRUSH
Elk	Sight, Sign		uc	uc	uc	uc	c	c
Deer, Mule	Sight, Sign	uc*	c	c	c	c	c	c
Mountain Lion	Sign	c*	c		c	c	c	c
Black Bear	Sign		c		c	c	c	c
Cottontail	Sight, Sign	c	c	c	c	c	c	c
Turkey	Sight, Sign		uc			c	c	c
Pheasant	Sound, Sight, Sign		c	c				
Chukar	Sight, Sign	c			c	c		
Mourning Dove	Sound, Sight, Sign	c	c	c	c	c	c	uc
Gambel's Quail	Records	c	c	uc	c			
Blue Grouse	Sight, Sign		uc		uc			
Beaver	Sight, Sign		c	uc	uc			c
Muskrat	Sight, Sign		c	c				
Skunk - Striped	Sight, Sign		c	c	uc			
- Spotted	Sight, Sign	c			c	c	c	
Badger	Sight, Sign	c	c	c	c	c	uc	uc
Gray Fox	Sight, Sign	c	c	c	c	c	c	uc
Weasel	Sight, Sign	c	uc		c	c	c	c
Ringtail Cat	Sign	c	uc		c	c		
Raccoon	Sign	uc	c	c				
Kit Fox	Sign	c	uc		c	c		
Coyote	Sight, Sign	c	c	c	c	c	c	c
Bobcat	Sight, Sign	uc	c	uc	c	c	c	c

*c = common

*uc = uncommon

Harvest data, number of hunters, and success can be used to determine the relative importance of an economic species. Tables III-2 through III-6 show these data for the inventoried species. While the game management units from which these data were obtained do not coincide perfectly with the study area, they are still valuable in describing the wildlife resource.

Table III-2. Deer Harvest, Pressure, and Success for Game Management Units 72 and 73

Year	Harvest	Number of Hunters	Percent Success
1977	718	2033	33
1976	710	1964	36
1975	550	1633	34
1974	729	1898	38
1973	1362	2950	46
1972	878	1683	52
1971	543	1236	44
1970	792	1693	47
1969	674	1426	47
1968	626	1241	50
Average	758	1776	43

Table III-3. Elk Harvest, Pressure, and Success for Game Management Unit 72 and 73.*

Year	Harvest	Hunters	Percent Success
1977	209	1268	16
1976	182	1230	15
1975	140	1111	13
1974	73	679	11
1973	46	694	7
1972	98	674	14
1971	118	1155	10
1970	114	826	14
1969	242	932	26
1968	214	881	24
Average	144	945	15

*Most of elk harvest occurs off study area.

Table III-4. Bear Harvest, Pressure, and Success for Game Management Units 72 and 73

Year	Harvest	Number of Hunters	Percent Success
1977	10	142	14
1976	6	70	9
1975	11	139	8
1974	3	11	27
1973	0	*	
1972	3	*	
1971	0	*	
1970	5	*	
1969	0	*	
1968	9	*	
Average	5	91	14.5

*Number of hunters unknown since no special license was required.

Table III-5. Upland Game Harvest, Pressure, and Recreational Use---Small Game Management Unit 90, 1975-77

	1977			1976			1975		
Species	Hunters	Harvest	Recreation Days	Hunters	Harvest	Recreation Days	Hunters	Harvest	Recreation Days
Cottontail Rabbit	897	5473	5279	878	7582	6934	1217	8345	9698
Pheasant	175	218	683	94	30	246	245	324	810
Chukar	23	0	28		No Season		No Season		
Mourning Dove	676	12858	3506	615	8427	2243	1044	18632	4705
Gambel's Quail	0	0	0	38	65	38	0	0	0
Turkey				22	7	--	22	0	--
Blue Grouse	396	1137	1745	425	1706	1507	481	1040	1164

Table III-6. Furbearer and Varmint Harvest, Pressure, and Recreational Use---Small Game Management Unit 90, 1975-77

	1977			1976			1975		
Species	Hunters	Harvest	Recreation Days	Hunters	Harvest	Recreation Days	Hunters	Harvest	Recreation Days
Beaver*	43	397	18925	35	616	1125	30	276	842
Muskrat*	26	412	910	25	962	947	25	1017	850
Skunk*									
Spotted	3	6	166	9	40	681	5	43	375
Striped	19	209	1282	22	184	1190	13	145	517
Badger*	20	70	1268	34	79	1544	14	4	580
Gray Fox*	25	80	1515	29	114	1733	14	59	693
Kit Fox	0	0	0	0	0	0	3	3	179
Weasel	6	81	228	4	30	33	3	17	181
Ringtail Cat	0	0	0	4	6	204	2	103	103
Coyote*	401	1180	5251	291	939	17573	376	1147	4380
Bobcat*	41	181	2468	121	311	3425	33	174	1306
Raccoon*	28	84	1322	39	124	1755	27	166	1402

*Harvest includes both sport hunting and trapping.

Sommers in his inventory efforts on nongame fauna of the study area observed 9 amphibians and reptiles, over 180 avians and 25 mammals. This is indicative of the high diversity of wildlife in the study area. He attributes much of this to the creation of a variety of artificial habitats that have been created by irrigation water supplied to this naturally arid area.

Table III-7 is a summary of Sommers' observations and opinion of probable project impact upon the nongame fauna of the study area.

The U.S. Fish and Wildlife Service indicated the possible presence of 4 threatened and/or endangered species that may occur in the study area or be affected by the project: Mesa-verde cactus, black-footed ferret, bald eagle and Colorado squawfish. Of these species, only the bald eagle has been recently observed in the probable impact area of the study area. A biological assessment will be completed to further assess presence and probable impacts of the proposed project on these species. Except for the bald eagle, which is present seasonally, it is believed the negative impacts will be insignificant due to the probable absence of the indicated species.

Using the U.S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP), an interagency project impact evaluation was made on the study area. The acreages for the various habitat types within the study area used in this HEP are given in Table III-8.

Species	Relative Abundance	Impact of Project
Amphibians and Reptiles		
Woodhouse's Toad	seasonally common	negative
Chorus Frog	seasonally common	negative
Leopard Frog	seasonally common	negative
Collared Lizard	seasonally common	none
Lesser Earless Lizard	seasonally common	none
Sagebrush Lizard	seasonally common	positive
Eastern Fence Lizard	seasonally common	none
Gopher Snake	seasonally common	none
Western Terrestrial Garter Snake	seasonally common	negative
Birds		
Common Loon	uncommon	none
Arctic Loon	uncommon	none
Horned Grebe	uncommon	none
Eared Grebe	seasonally common	none
Western Grebe	seasonally common	negative
Pied-billed Grebe	common	negative
Double-crested Cormorant	uncommon	none
Great Blue Heron	common	negative
Snowy Egret	seasonally common	negative
Black-crowned Night Heron	common	negative
American Bittern	uncommon	negative
White-faced Ibis	common	negative
Whistling Swan	uncommon	negative
Canada Goose	common	negative
Snow Goose	uncommon	negative
Mallard	common	negative
Gadwall	common	negative
Pintail	common	negative
Virginia Rail	common	negative
Sora	common	negative
American Coot	common	negative
Killdeer	common	negative
Semi-palmated Plover	common	negative
Common Snipe	common	negative
Spotted Sandpiper	common	negative
Solitary Sandpiper	uncommon	negative

Species	Relative Abundance	Impact of Project
Green-winged Teal	common	negative
Blue-winged Teal	seasonally common	negative
Cinnamon Teal	common	negative
American Wigeon	common	negative
Northern Shoveler	common	negative
Ring-necked Duck	common	negative
Redhead	seasonally common	none
Canvasback	seasonally common	none
Lesser Scaup	seasonally common	none
Common Goldeneye	seasonally common	none
Bufflehead	seasonally common	negative
Surf Scoter	uncommon	none
Ruddy Duck	common	negative
Common Merganser	common	none
Red-breasted Merganser	uncommon	none
Turkey Vulture	common	negative
Sharp-shinned Hawk	common	negative
Cooper's Hawk	common	negative
Red-tailed Hawk	common	negative
Rough-legged Hawk	seasonally common	negative
Golden Eagle	common	negative
Bald Eagle	seasonally common	negative
Northern Harrier	common	negative
Osprey	uncommon	negative
Prairie Falcon	uncommon	none
Peregrine Falcon	uncommon	none
American Kestrel	common	negative
Gambel's Quail	common	positive
Ring-necked Pheasant	common	negative
Virginia Rail	common	negative
Sora	common	negative
American Avocet	seasonally common	negative
Black-necked Stilt	uncommon	negative
Wilson's Phalarope	common	negative
Northern Phalarope	uncommon	negative
California Gull	uncommon	none
Ring-billed Gull	common	none
Franklin's Gull	uncommon	none
Bonaparte's Gull	uncommon	none

Table III-7. (Cont'd)

Species	Relative Abundance	Impact of Project
Birds (Cont'd)		
Willet	common	negative
Greater Yellowlegs	uncommon	negative
Lesser Yellowlegs	uncommon	negative
Long-billed Dowitcher	seasonally common	negative
Semi-palmated Sandpiper	seasonally common	negative
Western Sandpiper	common	negative
Marbled Godwit	seasonally common	negative
Forster's Tern	uncommon	none
Black-chinned Hummingbird	common	none
Broad-tailed Hummingbird	common	none
Rufous Hummingbird	common	none
Belted Kingfisher	common	negative
Common Flicker	common	negative
Lewis' Woodpecker	common	negative
Yellow-bellied Sapsucker	common	negative
Hairy Woodpecker	common	negative
Downy Woodpecker	common	negative
Western Kingbird	common	negative
Cassin's Kingbird	uncommon	negative
Ash-throated Flycatcher	common	negative
Say's Phoebe	common	negative
Western Flycatcher	common	negative
Western Wood Pewee	common	negative
Black-capped Chickadee	common	negative
Mountain Chickadee	common	negative
Plain Titmouse	common	negative
Common Bushtit	common	negative
White-breasted Nuthatch	common	negative
Brown Creeper	common	none
House Wren	common	negative
Bewick's Wren	common	negative
Long-billed Marsh Wren	common	negative
Canyon Wren	common	none
Rock Wren	common	positive
Mockingbird	uncommon	negative
Gray Catbird	common	negative
Sage Thrasher	common	positive
American Robin	common	negative
Black Tern	uncommon	none
Band-tailed Pigeon	seasonally common	negative
Rock Dove	common	none
Mourning Dove	common	none
Great Horned Owl	common	negative
Common Nighthawk	common	negative
White-throated Swift	common	negative
Olive-sided Flycatcher	common	negative
Horned Lark	common	positive
Violet-green Swallow	common	negative
Tree Swallow	common	negative
Bank Swallow	uncommon	negative
Rough-winged Swallow	common	negative
Barn Swallow	common	negative
Cliff Swallow	common	negative
Purple Martin	uncommon	negative
Steller's Jay	common	none
Scrub Jay	common	none
Black-billed Magpie	common	negative
Common Raven	common	negative
Common Crow	common	negative
Pinyon Jay	common	negative
Clark's Nutcracker	common	none
Hermit Thrush	common	negative
Western Bluebird	common	negative
Mountain Bluebird	common	negative
Townsend's Solitaire	common	negative
Blue-gray Gnatcatcher	common	none
Ruby-crowned Kinglet	common	none
Water Pipit	common	negative
Cedar Waxwing	common	negative
Northern Shrike	uncommon	positive
Loggerhead Shrike	common	positive
Starling	common	positive
Solitary Vireo	common	negative
Warbling Vireo	common	negative
Virginia's Warbler	common	negative
Yellow Warbler	common	negative
Yellow-rumped Warbler	common	negative

Table III-H. (Cont'd)

Species	Relative Abundance	Impact of Project
Birds (Cont'd)		
Black-throated Gray Warbler	uncommon	none
MacGillivray's Warbler	common	negative
Common Yellowthroat	common	negative
Yellow-breasted Chat	common	negative
Wilson's Warbler	common	negative
House Sparrow	common	positive
Western Meadowlark	common	positive
Yellow-headed Blackbird	common	negative
Red-winged Blackbird	common	negative
Northern Oriole	common	negative
Brewer's Blackbird	common	negative
Brown-headed Cowbird	common	negative
Western Tanager	common	negative
Black-headed Grosbeak	common	negative
Blue Grosbeak	common	negative
Indigo Bunting	uncommon	negative
Lazuli Bunting	common	negative
Evening Grosbeak	common	negative
Cassin's Finch	common	negative
House Finch	common	negative
Pine Siskin	common	negative
American Goldfinch	common	negative
Lesser Goldfinch	common	negative
Green-tailed Towhee	common	negative
Rufous-sided Towhee	common	none
Savannah Sparrow	common	negative
Vesper Sparrow	common	positive
Lark Sparrow	common	none
Black-throated Sparrow	uncommon	positive
Sage Sparrow	uncommon	positive
Dark-eyed Junco	seasonally common	negative
Gray-headed Junco	common	negative
Tree Sparrow	seasonally common	negative
Chipping Sparrow	common	positive
Brewer's Sparrow	common	positive
White-crowned Sparrow	common	negative
Song Sparrow	common	negative
Mammals		
Wandering Shrew	locally common	negative
Desert Cottontail	common	negative
Black-tailed Jackrabbit	common	positive
Rock Squirrel	common	negative
Gunnison's Prairie Dog	common	positive
Beaver	common	negative
Western Harvest Mouse	locally common	negative
Deer Mouse	common	positive
White-throated Woodrat	locally common	negative
Mexican Woodrat	locally common	negative
Montane Vole	locally common	negative
Muskrat	locally common	negative
Porcupine	common	negative
Coyote	common	negative
Raccoon	locally common	negative
Badger	common	positive
Striped Skunk	common	negative
Mule Deer	common	negative

Table III-8. Habitat Types and Acreages,
McElmo Creek Salinity Control Study, Colorado.

Habitat Type	Acres
Deciduous Shrub	19,754
Evergreen Shrub	40,796
Shrub Wetland *	881
Forest Wetland *	771
Carex Wetland *	7,160
Cattail Wetland *	2,203
Pasture/Hayland	25,780
Forest (P/J)	38,470
Orchard	800
Total	136,615

*Total wetland area 11,015 acres.

Analysis of the HEP data indicated that while there would be alterations and losses of wetlands, conversion of these wetlands to more xeric wetland types or to other habitat types would result in a small gain in average annual habitat units.

Under the future without project alternative (Alternative Plan 1), the HEP Team concluded there would be a loss of 1,850 acres of wetland habitat over time. The majority of this, 1,100 acres, could come from the carex wetlands which are even now extensively used for pasture.

The HEP Team evaluated project-related impacts for essentially the conditions found in Alternative Plan 5. It was assumed that a 10-year installation period would be required. Analysis by the HEP Team indicated the probable loss, due to project action, of 1,750 acres of wetlands.

Essentially, the wetland losses with the project and without the project are the same. Therefore, there will be no significant adverse impacts attributable to salinity program implementation.

Wetland conservation and protection and water quality are areas of national environmental concern. Where two areas of environmental concern are involved, trade-offs are a valid consideration. Table III-9 indicates the acres of wetlands lost per 1,000 tons reduction in salt loading to the Colorado River system.

Table III-9. Anticipated Wetland Habitat Losses and Salt Reduction, By Alternative Plans, McElmo Creek Salinity Control Study, Colorado.

Alternative Plan	Wetland Losses (Ac)	Salt Reduction (1000 Tons)	Wetland Losses (Ac) (ac per 1000 Tons Salt Reduction)
1	1850	Gain in Salt	--
2	1725	13	133
3	1750	24	73
4	1725	37	47
5	1750	38	46
6	1800	27	67

Programs of Other Agencies

The McPhee Dam, being constructed under the USBR's Dolores Project, will provide storage capacity of 381,000 acre feet and will provide supplemental water to 26,300 acres and a full irrigation supply for 35,360 acres of new land. Farmers in the Montezuma Valley may continue operations as in the past or they may purchase project water.

This USDA study assumed no water shortages for irrigated land treated under the Salinity Control Program and claims no onfarm benefits as a result of water available from the Dolores Project. The effect of converting dry cropland to irrigation outside of the McElmo Creek drainage area and the effect of the proposed Towac Canal through the Montezuma Valley were not evaluated in this study. It was assumed that farming methods in the Montezuma Valley will not change because of the Dolores Project.

IV. PROBLEMS AND NEEDS

Historical

Salinity ultimately becomes a major problem in many irrigated areas. Areas with high saline soils, such as southwestern Colorado, has affected water quality since irrigation was first attempted because the irrigated land and diffused source areas contain large deposits of salts. Salinity concentrations in the Colorado River adversely affect downstream irrigated crop production and other water uses. The problem is especially severe for water delivered to California, Arizona and Mexico.

The Colorado River system naturally carries a large load of salts (dissolved solids) and suspended sediment. Streamflow depletions resulting from transbasin diversions and for irrigation, municipal and industrial uses while actually reducing the salt load, significantly reduces the supply of water available for dilution of salt loads in the lower river system. Future development of compact apportioned water by the Basin states will further reduce the water available for dilution, and in some cases the development projects themselves may increase salt loadings in the river system.

Recognition of the water quality problem in the region has caused a number of studies to be made since 1960. The Colorado River Basin Water Quality Control Project was established in 1960 by the Division of Water Supply and Pollution Control, U.S. Public Health Service. Studies by the Environmental Protection Agency (1971) produced a series of reports on "The Mineral Quality Problem in the Colorado River Basin". Salinity in the river also is documented by the Bureau of Reclamation (1972 and 1974) Status Reports - Colorado River Water Quality Improvements Program, and U.S. Geological Survey Professional Paper 441, "Water Resources of the Upper Colorado River Basin - Technical Report" by Iorns and others (1965).

Section 303 of the Clean Water Act requires adoption of water quality standards applicable to interstate waters. The Act's objective is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101), and the Administrator of EPA is required, in cooperation with other Federal, State and local agencies, "to develop comprehensive programs for preventing, reducing, or eliminating the pollution of navigable waters and ground waters (Section 102a)."

The seven states of the Colorado River Basin acting through the Colorado River Basin Salinity Control Forum developed and agreed upon basinwide water quality standards for salinity including numeric criteria, and plan of implementation for salinity control in 1975 (1975 Forum report). Each of the water quality standards was adopted basin-wide subsequently approved by EPA. The 1975 report described the rationale for selecting the criteria and the gaging station locations.

In response to Section 303(c) of the Clean Water Act, the Forum in 1978 reviewed the standards. The Forum determined that the 1975 criteria were appropriate. The Forum also reviewed and modified the plan of implementation in 1978. Appropriate documents were adopted by the states.

Again, in 1981, the Forum in response to Section 303(c) reviewed the criteria and determined that the 1975 criteria are still appropriate. The numeric critera are:

Below Hoover Dam	723 mg/L
Below Parker Dam	747 mg/L
Imperial Dam	879 mg/L

The plan of implementation was reviewed in 1981 and modified to reflect changes that have occurred since 1978. The principal components of the plan are:

1. Prompt construction by the Department of the Interior of two salinity control units authorized by Section 202, Title II, of Public Law 93-320, namely the Paradox Valley and Grand Valley Units.

2. Expeditious authorization and construction by the Department of the Interior of the Meeker Dome Unit and 10 of the units listed in Section 203(a)(1), Title II of Public Law 93-320, or their equivalents after receipt of favorable planning reports.

3. Expenditious implementation by the Department of Agriculture of onfarm and related measures for salinity control.

4. Implementation of salinity control measures by the Bureau of Land Management to reduce salt contribution from public domain lands.

5. The placing of effluent limitations, principally under the National Pollutant Discharge Elimination System (NPDES) permit program, provided for in Section 402 of the Clean Water Act of 1977 on industrial and municipal discharges based on the Forum's 1977 policy on salinity control through the NPDES permits.

6. Implementation of the 1980 Forum policy for the use of brackish and/or saline waters for industrial purposes.

7. Inclusion of the 208 Water Quality Management Plans. Individually, the Basin states have developed water quality management plans to conform to the requirements of Section 208 of the Clean Water Act. The water quality management planning process is continuing. As the plans are refined or new elements added and after such changes have been adopted by the states and approved by EPA, those portions of the plans dealing with salinity control will become part of the implementation plan.

SALINITY PROBLEMS IN THE McELMO CREEK UNIT

Salt Sources - Analysis of water quality data by the U.S. Geological Survey inidicates that McElmo Creek contributes about 115,000 tons of salt annually to the Colorado River. Most of these salts are leached from the soil and underlying Mancos shale and carried into the river by deep percolation from irrigation and seepage from water delivery and tailwater return flow systems.

Both natural runoff and irrigation contribute to the problem, either by salt concentration or by salt loading. Salt concentration is caused by removal of water from the river system through consumptive use by irrigated crops and other vegetation, and by evaporation; mineral constituents are thereby concentrated in the water that remains. Salt loading occurs as ground water dissolves subsurface minerals while flowing through the salt laden soils and shale layers. Although both salt concentration and salt loading are at work, salt loading is the major cause of the salinity increase.

Salt loading from irrigated cropland is related to subsurface return flows. The irrigation water applied is generally of good quality and most fields are irrigated in excess of normal crop needs. Deep percolation of excess irrigation water causes substantial return flows through layers of Mancos shale that contain large quantities of undissolved salt (solids). The concentration of dissolved salts (solids) transferred to the percolating water seriously degrade the quality of water delivered to the Colorado River.

Of the 115,000 tons of salt that McElmo Creek delivers annually to the Colorado River about 46,000 tons come from onfarm irrigation systems and practices, and about 8,000 tons from small off-farm laterals (See Table IV-1). With voluntary participation by seventy percent of the farmers, the salt load from onfarm sources can be reduced by as much as 38,000 tons (70 percent) depending on which alternative plan is implemented.

TABLE IV-1, SUMMARY OF ANNUAL SALT LOADING AND POTENTIAL REDUCTION ATTRIBUTED TO IRRIGATED AGRICULTURE.
McELMO CREEK SALINITY CONTROL STUDY, COLORADO.

Source of Loading	Present	Plan Number					
		1	2 1/	3	4	5	6
	-----------------	-----------	-----------	tons	-----------	-----------	-----------
Group Ditches	8000	9000	8000	0	0	0	0
OnFarm Ditches	14000	15000	15000	14000	3000	2000	0
Deep Percolation 2/3/	32000	36000	24000	22000	20000	20000	33000
Totals	54000	60000	47000	36000	23000	22000	33000
Potential for Reduction							
Group Ditches	---	-1000	0	8000	8000	8000	8000
OnFarm Ditches	---	-1000	-1000	0	11000	12000	14000
Deep Percolation	---	-4000	8000	10000	12000	12000	-1000
Sub-Total 4/	---	-6000	7000	18000	31000	32000	21000
Potential for Prevention							
Irrigation Water Management	---	---	6000	6000	6000	6000	0
Total Salt Reduction	---	-6000	13000	24000	37000	38000	21000

1/Plan 2 is the Management Only Plan and will have little effect on reducing salt loading from ditch seepage. The plans are further described in section 5. e
2/The present case and Plans 1 and 2 include 5,000 tons/year from Navajo Wash, a separate tributary to the San Juan River.
3/Plans 3, 4 and 5 include about 2,000 tons/year from Navajo Wash.
4/Reduced salt load going to the Colorado River. Plans 2 through 5 will hav an additional 6,000 ton prevention benefit due to management of supplemental irrigation water available from the Dolores Project.

SALT LOADING

Salt loading accounts for salt pickup through deep percolation from field irrigation, and seepage from earthen ditches. Irrigation water delivered to the farms has an average salt concentration of about 200-300 milligrams per liter (mg/l). Base flow returning to McElmo Creek has a concentration of about 2,600 mg/l. Salts are concentrated in soil moisture through evaporation and as plants extract water and minerals needed for growth. Excess irrigation water lost through deep percolation, seepage from earthen delivery ditches and from tailwater runoff increases the total salt load by passing through the saline soil and shale formation and resurfacing

at the deeper natural drainages that ultimately convey return flows back to the river system. Flow in these drains occurs near the groundwater level, so essentially no seepage losses occur.

Volume of seepage and deep percolation, determined for each of six drainage areas, was used to calculate the salt load. Although average deep percolation is about 0.3 acre-feet per acre per year, the salt load from these areas ranges from 1.8 to 3.8 tons per acre per year. This range in salt loads suggests examining the potential salt load reduction from each drainage area to determine priorities for treatment.

WATER SUPPLY MANAGEMENT

Total crop irrigation requirement is estimated to be 54,000 acre-feet per year or about 1.8 acre-feet per acre. Present seasonal net irrigation is estimated to be 47,000 acre-feet, about 87 percent of the total requirement. Present farm delivery, estimated to be about 107,000 acre-feet, averages 3.7 acre-feet per acre and is 1.9 acre-feet per acre more than is required. Much of the excess water delivered to the farm contributes to salt loading from the irrigated land.

WATER BUDGET ANALYSIS

Irrigation water diverted from the Dolores River is transported through a network of canals and laterals to the farms. Evaluation of transmission losses occurring through seepage, evaporation, transpiration and spillage from the Montezuma Valley Irrigation Canal System have been evaluated by the Bureau of Reclamation. Analysis indicates that of the water diverted for irrigation, about 107,000 acre-feet ultimately reaches the farms and present estimated onfarm irrigation efficiency averages about 45 percent (See Table IV-2). Irrigation water, classified by components related to the irrigation process, is defined as follows:

(1) Seepage - Water losses from the off-farm and the onfarm supply and field head ditches and tailwater return flows.

(2) Deep percolation - The irrigation water which moves through and below the root zone and is not available for plant growth.

(3) Runoff - The irrigation water leaving the field as surface flow and discharging into drainage channels. Some runoff seeps from tailwater pickup ditches or may be intercepted and reused.

(4) Crop Use (seasonal net application) - The water consumptively used by the crop (evapotranspiration). It is the water supplied by irrigation, exclusive of precipitation, that is stored in the root zone for use by the plants and must be replenished periodically to sustain plant growth.

(5) Onfarm Irrigation Efficiency (efficiency of irrigation) - Efficiency is the crop use, less effective precipitation divided by farm delivery multiplied by 100.

Table IV-2, results of the Water Budget Analysis, compares the present conditions with results expected from each of six alternative plans for onfarm improvement.

Analysis reveals that present irrigation practice effectively provides only 87 percent of crop consumptive use requirements. The estimated crop consumptive use requirement for the 29,100 acres is 54,000 acre-feet per year. Meeting crop consumptive requirement is an objective of the six alternative plans; increasing the efficiency of irrigation while reducing deep percolation to the maximum extent possible is another objective. Reducing runoff by installing sprinkler irrigation systems or by adjusting the flow rate, the time of set and the frequency of irrigation in surface irrigation systems are key factors in increasing irrigation efficiency.

TABLE IV-2 WATER BUDGET FOR ONFARM IRRIGATION
Mc ELMO CREEK SALINITY CONTROL STUDY, COLORADO

ITEM	PRESENT	ALTERNATIVE PLAN NUMBER 1 3/	2	3	4	5	6
		ac. ft./yr.					
Irrigation Supply	107,000	121,000	90,000	84,000	85,000	85,000	114,000
Group Ditch Seepage	2,000	3,000	3,000	0	0	0	0
Farm Delivery	105,000	118,000	87,000	84,000	85,000	85,000	114,000
Onfarm Ditch Seepage 2/	4,000	4,000	4,000	1,000	1,000	1,000	0
Seasonal Gross App.	101,000	114,000	83,000	83,000	84,000	84,000	114,000
Seasonal Net App. 1/	47,000	54,000	54,000	54,000	54,000	54,000	54,000
Seasonal Deep Perc. 2/	9,000	10,000	7,000	7,000	7,000	7,000	10,000
Seasonal Runoff 2/	45,000	51,000	26,000	25,000	20,000	15,000	51,000
Adequacy of Irrigation	87%	100%	100%	100%	100%	100%	100%
Efficiency of Irrigation	45%	45%	60%	64%	64%	64%	47%

1/ Under present conditons the Montezuma Valley Irrigation Company experiences about a 13 percent shortage in its annual irrigation requirements, ususally in late summer. The annual shortage will be alleviated with completion of the Dolores Project by the Bureau of Reclamation.

2/ Consumptive use by phreatophytic vegetation has not been separately evaluated, however, it is recognized that runoff, deep percolation and ditch seepage are primary sources of water for such vegetation, therefore, not all of the runoff and seepage water indicated here will drain from the valley.

3/ Under Plan One seepage reductions are insignificant when rounding numbers to closest 1,000.

Improvement is needed throughout the existing conveyance, distribution, application and return systems. Reduced salt loading will require total system emphasis to divert the amount of water needed for crop consumptive use requirements, leaching, cultural practices and unavoidable seepage and spillage losses or deep percolation. Because the primary source of salt pick up is from the underlying Mancos shale formation, overall emphasis must be placed on reducing seepage from canals, laterals and onfarm ditches, reducing deep percolation from field irrigation, and in maintaining positive control over return flows to reduce erosion from fields and drains.

V. PLAN FORMULATION AND THE ALTERNATIVE PLANS

Three basic solutions were evaluated in plan formulation. Under the first solution the effects of onfarm management of irrigation water using existing irrigation systems and methods were examined. Effective and efficient irrigation requires uniform application of water across the field while applying the needed amount of water. Measuring devices are needed to measure the rate at which water is delivered to the field. The duration of flow must be carefully timed to assure application of the proper amount of water. Thus, the management only solution requires controlling the time of each irrigation set and the flow rate supplemented by installing water measuring devices. This solution assumes that, using manual labor, irrigators will use the recommended flow rate and will irrigate to the recommended time of set thus reducing the volume of deep percolation and volume of runoff from each field. The recommended flow rate and the time of set, calculated for each field, will be part of the landowner's conservation plan.

The second solution considers only ditch lining where existing earth ditches would be replaced by pipelines or by gated pipe to reduce seepage. A significant share of the salt load pickup is attributed to seepage from earth ditches. Reorganization of planned systems will require that water be delivered to the farm at the proper location, elevation, quantity and pressure suited to planned improvements. Therefore, the ditch lining solution examined the cost and the effect of implementing a program for lining existing ditches or installing pipelines or gated pipe and includes improving the off-farm group ditches for water delivery below the Montezuma Valley Irrigation System. Additionally, onfarm improvements will include control valves that accomodate semi-automated timing devices to shut off the flow of water at the prescribed time. However, installation of semi-automatic

TABLE V-1 SUMMARY OF ALTERNATIVE PLANS 4/
McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Plan Description	Action	Total Cost 2/ (——$1,000——)	Annual Net 3/ Benefit (——$1,000——)	Area Treated: Surface Systems (ac.)	Area Treated: Sprinkler Systems (ac.)	Annual Salt Reduction (tons)	Average Annual Cost ($1,000/mg)
1. Continuation of	Onfarm	5/		-		-5,000	
Ongoing Programs	Off-Farm	5/		-		-1,000	
	Total	795		28,450	0	-6,000	—
2. Irrigation Water 1/	Onfarm	5,538		-		7,000	689
Management	Off-Farm	0		-		0	0
	Total	5,538	854	20,900	0	7,000	689
3. Irrigation Water	Onfarm	6,187		-		10,000	539
Management With	Off-Farm	7,363		-		8,000	801
Limited Sprinklers	Total	13,550	829	20,900	650	18,000 6/	655
4. Irrigation Water	Onfarm	18,719		-		23,000	709
Management With	Off-Farm	7,363		-		8,000	801
Gravity Sprinklers	Total	26,082	1,153	10,650	10,400	31,000 6/	733
5. Irrigation Water	Onfarm	20,619		-		24,000	748
Management With	Off-Farm	7,363		-		8,000	801
Sprinklers	Total	27,982	1,251	1,850	19,700	32,000 6/	761
6. Ditch Lining Only	Onfarm	12,113		-		13,000	811
	Off-Farm	7,363		-		8,000	801
	Total	19,476	209	28,450	0	21,000	807

1/ Off-Farm improvements are not included with this program emphasizing onfarm irrigation water management only.
2/ July 1981 Price Base.
3/ Costs amortized at 7 5/8 percent interest over 25 years.
4/ Benefits and costs computed in present value terms using six year installation period.
5/ Total Cost was not disaggregated into onfarm and off-farm components.
6/ Does not include the potential 6,000 ton annual salt load anticipated from future irrigation with Dolores Project water that would enter the rive if onfarm salinity control measures are not implemented.

TABLE V-2 CLASSIFICATION OF IRRIGATED LAND
USED FOR PLANNING THE
ONFARM IMPROVEMENT PROGRAM

McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Sub-Area	Potential For Pumped Sprinkler 1/	Surface System 1/	Unimproved Surface		Potential For Gravity Sprinkler 2/	Surface System 2/	Unimproved Surface		Total Area
			Criteria Limitation	Farmer			Criteria Limitation	Farmer Choice	
	---------	--------	----------	---------	--Acres--	--------	----------	--------	--------
Alkali	1,000	400	150	1,800	3,100	450	---	900	7,900
Hartman	1,250	100	100	350	3,700	200	100	1,300	7,100
McElmo Cr.	3,100	200	150	1,000	1,600	150	---	500	6,700
Mud Creek	2,700	200	100	900	850	50	---	300	5,100
Crow Creek	---	---	---	---	700	50	50	200	1,000
Navajo	650	50	---	200	300	---	---	100	1,300
Totals	8,800	950	500	4,250	10,250	900	150	3,300	29,100
Plan 1	8,800	950	---	4,250	10,250	900	---	3,300	28,450
Plan 2	8,800	950	---	---	10,250	900	---	---	20,450
Plan 3	8,800	950	500 3/	---	10,250	900	150 4/	---	21,550
Plan 4	8,800	950	---	---	10,250	900	150 4/	---	21,050
Plan 5	8,800	950	500 3/	---	10,250	900	150 4/	---	21,550
Plan 6	8,800	950	---	4,250	10,250	900	---	3,300	28,450

1/ Gravity Pressure cannot be developed.
2/ Gravity Pressure can be developed.
3/ Served by pumped sprinkler systems.
4/ Served by gravity sprinkler systems.

timing devices for salinity control, although encouraged by SCS, is optional, available to those who may want them but not required for participation in the program.

The third solution considered the effect of combining irrigation water management with ditch lining. Sprinkler irrigation systems are included as a feature of irrigation water management because a higher degree of management is more likely to be achieved with sprinklers than by controlling time of set and flow rate used with existing surface systems and methods. Pipelines are needed in all off-farm group ditches leading from the Montezuma Valley Irrigation System to preserve as much gravity pressure as possible for sprinkler operation. Only part of the irrigated land can be served by gravity pressure, therefore, pumped pressure will be needed to operate sprinklers in the remainder of the area.

Six alternative plans that satisfy the plan formulation objectives are displayed in Table V-1 and are the candidate plans presented for further consideration by the local people and others who share responsibility for selecting the recommended plan. The acreage identified for treatment under each alternative plan depends on the proposed improvement. Classification of irrigated land by type of improvement is shown in Table V-2. The classification, based on local judgement, suggests that some landowners desire to change from present surface systems to sprinkler irrigation expecially where qravity pressure can be developed. Some may choose only to improve their present surface system and some may choose not to improve any of their system. The table also shows that assistance may not be made available to improve some existing surface systems because the land slope is too steep for irrigation without causing erosion. However, these steeper lands may be irrigated safely using properly designed and operated sprinkler systems.

Plan One - Continuation of Ongoing Programs-28,450 Acres

This plan assumes continuation of ongoing conservation programs. Landowners in the valley are actively applying conservation land treatment. Some treatment is applied by individuals on land under their control while other practices are implemented by groups of landowners for mutual benefit. Rates of implementation are influenced by the amount of funds available through government cost-share assistance programs, the practices eligible for government assistance, and the financial resources of landowners to install irrigation improvement measures. Application of soil and water conservation practices is expected to continue whether or not an accelerated program for salinity control is forthcoming.

Implementation of this plan will not reduce the amount of water diverted annually for irrigation. Annual seepage from onfarm ditches would would be reduced by about 100 acre-feet. Improved onfarm management of irrigation water would provide 47,000 acre-feet of water annually for consumptive use by farm crops throughout the valley. Annual return flow to the river system, the sum of seepage, deep percolation and tailwater runoff, essentially would not be reduced.

Annual funding under USDA's Agricultural Conservation Program for federal cost-share assistance allocated within the study area during the past five years has averaged about $86,000. The most common conservation practices installed under that level of funding are ditch lining or pipeline. The quantities and costs of conservation practices expected to be installed during the next six years, assuming continuation of present levels of funding and cost-share rates are:

Plan Number 1
ESTIMATED QUANTITIES AND COST

Practice	Unit	Quantity	Estimated Cost
Ditch Lining	Mi	14	$200,000
Pipeline	Mi	41	595,000
Total Cost			795,000

Adquate management practices have been applied on less than about 3 percent of the irrigated area and therefore, salt loading from that area is not significant. Continuation of the going program is expected to bring about another 4 percent of the area within acceptable limits during the next six years.

Under Alternative Plan One a maximum salt load reduction of about 2,000 tons per year, a reduction of less than 4 percent, can be attained.

Plan Two - Irrigation Water Management - 20,900 acres

This non-structural plan assumes installing only water measuring devices for improved irrigation water management using existing irrigation systems and methods. The irrigated area targeted for improvement is 20,900 acres. Lining or pipelines for off-farm laterals and onfarm ditches is not included.

This plan can be implemented at a one-time construction cost of $4,619,000. Technical assistance and administrative costs, estimated to be $924,000, make a total installation cost of $5,543,000. Capitalized Annual Cost including operation, maintence, and replacement is $859,100. Capitalized annual net benefits are estimated to be $383,400.

Implementation of this plan would not increase the amount of water diverted annually for irrigation. Seepage from onfarm ditches would not be reduced and deep percolation would be reduced by 2,000 acre-feet. Improved onfarm management of irrigation water would provide 54,000 acre-feet of water for consumptive use by farm crops in the valley. Annual return flow to the river system, the sum of seepage, deep percolation and tailwater runoff, would be reduced by 21,000 acre-feet. (See Table A1-4).

The 17,000 ton reduction in salt load represents a 31 percent reduction in the total salt load being delivered to the Colorado River from onfarm irrigation sources in the McElmo Creek Basin.

PLAN NUMBER 2
ESTIMATED QUANTITIES AND COSTS

Item	Units	Quantities	Cost
PIPELINE:			
GROUP DITCHES	mi.	0	0
FARM DITCHES	mi.	0	0
MEASURING DEVICES	ea.	4,200	4,619,000
SPRINKLER SYSTEMS:			
GRAVITY PRESSURE	ac.	0	0
PUMPED PRESSURE	ac.	0	0
TOTAL COST	$		4,619,000

Irrigation water management alone may not be widely accepted. Existing irrigation practices are the result of farmer experience and judgement, of water supply and of limited financial resources for implementating system improvements. Without the incentive of better systems for more uniform application of irrigation water there is little likelyhood that present practices will be changed significantly.

Plan Three - Irrigation Water Management and Ditch Lining with Limited Sprinkler Systems - 21,550 Acres.

This is the same as Plan Two, except that 650 acres of irrigated land have been added where sprinkler irrigation is the only technically feasible means of achieving irrigation water management. With the addition of sprinkler irrigation all of the off-farm group ditches would be placed in pipe to preserve gravity pressure for proper operation of the sprinklers. In addition to gravity pressure for 150 acres of the land, booster pumps will be needed to develop sufficient pressure to operate sprinklers on the remaining 500 acres of land.

This plan can be implemented at a one-time construction cost of $11,292,000. Technical assistance and administrative costs, estimated to be $2,258,000, make a total installation cost of 13,550,000.

Capitalized annual cost, including operation, maintence and replacement is $1,764,200. 1/ Capitalized annual net benefits are estimated to be $269,600.

Implementation of this plan would not increase the amount of water diverted annually for irrigation. Seepage from onfarm ditches would be reduced by 3,000 acre-feet and deep percolation would be reduced by 20,000 acre-feet. Improved onfarm management of irrigation water would provide

1/ Includes $23.00 per acre pumping cost for 500 acres.

54,000 acre-feet of water for consumptive use by farm crops throughout the valley. Annual return flow to the river system, the sum of seepage, deep percolation and tailwater runoff, would be reduced by 25,000 acre-feet. (See Table A1-4).

The 18,000 ton reduction in salt load represents a 33 percent reduction in the total salt load being delivered to the Colorado River from onfarm irrigation sources in the McElmo Creek Basin.

PLAN NUMBER 3
ESTIMATED QUANTITIES AND COSTS

Item	Units	Quantities	Cost
PIPELINE:			
GROUP DITCHES	mi.	235	6,136,000
FARM DITCHES	mi.	0	0
MEASURING DEVICES	ea.	4,200	4,619,000
SPRINKLER SYSTEMS:			
GRAVITY PRESSURE	ac.	150	117,000
PUMPED PRESSURE	ac.	500	420,000
TOTAL COST	$		11,292,000

Plan Four - Irrigation Water Management and Ditch Lining with Gravity Pressurized Sprinkler Systems - 21,050 Acres

This plan assumes installing sprinkler systems on 10,400 acrs of irrigated land that can be adequately served by gravity pressure only. Irrigation water management on the other 10,650 acres of irrigated land

would be achieved by properly controlling the time of set and the flow rate using existing surface irrigation systems. The off-farm group ditches would be placed in pipe to preserve gravity pressure for operating the sprinklers. Additionally, pipeline, gated pipe, or ditch lining is included to reduce ditch seepage from land not being converted to sprinkler systems.

This plan can be implemented at a one-time construction cost of $21,735,000. Technical assistance and administrative costs, estimated to be $4,374,000, make a total installation cost of $26,082,000.

The capitalized Annual Cost including operation, maintenance and replacement is $3,121,300. Capitalized annual net benefits are estimated to be $330,600.

Implementation of this plan would not increase the amount of water diverted annually for irrigation. Seepage from onfarm ditches would be reduced by 3,000 acre-feet and deep percolation would be reduced by 25,000 acre-feet. Improved onfarm management of irrigation water would provide 54,000 acre-feet of water for consumptive use by farm crops throughout the valley. Annual return flow to the river systems, the sum of seepage, deep percolation and tailwater runoff, would be reduced by 30,000 acre-feet (See Table A1-4).

The 31,000 ton reduction in salt load represents a 57 percent reduction in the total salt load being delivered to the Colorado River from onfarm irrigation sources in the McElmo Creek Basin.

PLAN NUMBER 4
ESTIMATED QUANTITIES AND COST

Item	Units	Quantity	Cost
PIPELINE:			
GROUP DITCHES	mi.	235	6,136,000
FARM DITCHES	mi.	190	5,144,000
MEASURING DEVICES	ea.	2,100	2,354,000
SPRINKLER SYSTEMS:			
GRAVITY PRESSURE	ac.	10,400	8,101,000
PUMPED PRESSURE	ac.	0	0
TOTAL COST	$		21,735,000

Plan Five - Irrigation Water Management Using Sprinkler Systems - 21,550 Acres

This plan assumes installing sprinkler irrigation systems operating with gravity and pumped pressure on 19,700 acres of irrigated land. The off-farm group ditches would be placed in pipe to preserve gravity pressure and pumps would be added at the farm to develop sufficient pressure to operate sprinklers for 9,300 acres being converted to sprinkler irrigation. Pipelines, gated pipe, or ditch lining would be installed to reduce ditch seepage from 1,850 acres of irrigated land not converted to sprinklers.

This plan can be implemented at a one-time construction cost of $23,322,000. Technical assistance and administrative costs, estimated to be $4,664,000, make a total installation cost of $27,986,000.

The Capitalized Annual cost including operation, maintence and replacement is $3,304,900.1/ Capitalized annual net benefits are estimated to be $420,200.

Implementation of this plan would not increase the amount of water diverted annually for irrigation. Seepage from onfarm ditches would be reduced by 3,000 acre-feet and deep percolation would be reduced by 30,000 acre-feet. Improved onfarm management of irrigation water would provide 54,000 acre-feet of water for consumptive use by farm crops throughout the

1/ Includes $23.00 per acre pumping costs for 9,300 acres.

valley. Annual return flow to the river system, the sum of seepage, deep percolation and tailwater runoff, would be reduced by 35,000 acre-feet. (See Table A1-4).

The 32,000 ton reduction in salt load represents a 59 percent reduction in the total salt load being delivered to the Colorado River from onfarm irrigation sources in the McElmo Creek Basin.

PLAN NUMBER 5
ESTIMATED QUANTITIES AND COSTS

Item	Units	Quantities	Cost
PIPELINE:			
GROUP DITCHES	mi.	235	6,136,000
FARM DITCHES	mi.	33	893,000
MEASURING DEVICES	ea.	400	408,000
SPRINKLER SYSTEMS			
GRAVITY PRESSURE	ac.	10,400	8,101,000
PUMPED PRESSURE	ac.	9,300	7,784,000
TOTAL COST	$		23,322,000

Plan Six - Ditch Lining Only - 28,450 Acres

This plan assumes ditch lining would be the only practice installed under the Salinity Control Program. Group ditches in the entire off-farm delivery system are included along with the farm ditches on individual fields and farms. Preserving gravity pressure would not be required, therefore, open ditches with concrete lining would be considered for installation along with pipe.

THE ONE-TIME CONSTRUCTION COST FOR IMPLEMENTING THIS PLAN IS:

Item	Construction Cost	Technical and Administrative Assistance	Total
CAPITOL COST:			
GROUP DITCHES	6,136,000	1,227,000	7,363,000
FARM DITCHES	10,094,000	2,019,000	12,113,000
TOTALS	16,230,000	3,246,000	19,476,000
AVERAGE ANNUAL COST:			
GROUP DITCHES	556,000	111,000	667,000
FARM DITCHES	916,000	183,000	1,099,000
TOTALS	1,472,000	294,000	1,766,000

1/ July 1981 Price Base, Amortized at 7 5/8%, over 25 years.

Capitalized Annual Cost including operation, maintenance and replacement is estimated to be $2,189,900. Capitalized Annual net benefits are estimated to be a negative (-) $690,200. Implementation of this plan could reduce the amount of water diverted annually for irrigation by 6,000 acre-feet, because seepage from onfarm ditches would be essentially eliminated. Annual return flow to the river system, the sum of seepage, deep percolation and tailwater runoff, would not be reduced.

The 21,000 ton reduction in salt loading represents a 39 percent reduction in the total salt load from irrigation being delivered to the Colorado River.

PLAN NUMBER 6
ESTIMATED QUANTITIES AND COSTS

Item	Units	Quantities	Cost
PIPELINE:			
GROUP DITCHES	mi.	235	6,136,000
FARM DITCHES	mi.	370	10,094,000
MEASURING DEVICES	ea.	0	0
SPRINKLER SYSTEMS:			
GRAVITY PRESSURE	ac.	0	0
PUMPED PRESSURE	ac.	0	0
TOTAL COST	$		16,230,000

Additional Alternatives

Categorical retirement of irrigated land is not a locally acceptable alternative. Agriculture is the major economic force in the valley and a land retirement alternative suggests the complete loss of this sector of the economy.

Selective retirement of irrigated land is an option for use with the other alternatives; however, specific areas to be retired have not been identified at this stage of planning. Criteria for selective land retirement include salinity contribution, cost of onfarm and off-farm improvements relative to land values, crop yields, and suitability of retired land as a replacement for lost wetlands. Site specific recommendations for land retirement will be made during detailed planning for implementation when actual costs of improvement can be compared with current land values, and onfarm benefits, and subjected to decision by the landowner.

In addition to the onfarm salinity control program several proposals for off-farm salinity control have been examined by the U.S. Bureau of Reclamation. Those proposals include:

Canal Lining: Reaches of canals having high seepage losses in highly saline soils would be lined. This proposal includes combining canals where possible.

Collection and Storage: Saline water would be collected and stored in solar evaporation ponds, or exported for power plant cooling, or exported in coal slurry pipelines.

Desalting: Construct a desalting plant to remove salts from the water out of the basin.

Public Participation

Public participation in the McElmo Creek Salinity Study began in December 1976 when the Bureau of Reclamation issued an invitation for interested agencies, groups and individuals to participate in formulating an interagency, interdisciplinary, multi-objective planning (MOP) team. The organizational meeting was held in Cortez, Colorado in February 1978. Soil Conservation Service personnel are participating members of the MOP Team and some of its sub-units. These sub-units conduct evaluations and analyses related to each discipline and then meet together as a full MOP Team to present results, to resolve interdisciplinary problems and to set the direction for the overall study.

VI. RECOMMENDED PLAN

Plan 5 is recommended for implementation. This plan was selected after considering local reaction from reviewing the six candidate plans at public meetings with farmers and ranchers in the valley and after considering comments on the Draft Report received from officials of local, state and federal agencies and from other interested groups. Major factors influencing the selection include the desires of local landowners and operators, cost effective salinity reduction, overall implementation cost, and program administration. Program implementation will extend over a six year period. Effectiveness of the program should be monitored and the data evaluated at three year intervals to determine whether the improvements are achieving the expected degree of salinity reduction.

Plan Description

When completed implementation of the recommended plan will result in a 32,000 ton per year reduction in salt loading, about a 59 percent reduction in the 54,000 ton salt load delivered annually to the Colorado River from irrigation sources in the McElmo Creek Basin.

The estimated total installation cost is $27,986,000. Of this amount $17,186,000 is the construction cost for onfarm improvements, $6,136,000 is the construction cost for 235 miles of off-farm lateral improvements, and $4,664,000 is the cost of administrative and technical assistance. After the recommended plan is fully implemented the annual local cost for operation, maintenance and replacement is estimated to be $184,300. The capitalized annual cost including operation, maintenance and replacement is $3,304,900, expressed in present value terms. Capitalized annual benefits is $3,725,100 giving capitalized annual net benefits of $420,200.

TABLE VI-1 ESTIMATED QUANTITIES AND COST FOR IMPLEMENTING THE RECOMMENDED PLAN
McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Item	Units	Quantities	Cost
Pipeline:			
Group Ditches	mi.	235	6,136,000
OnFarm Ditches	mi.	33	893,000
Measuring Devices	ea.	400	408,000
Sprinkler Systems			
Gravity Pressure	ac.	10,000	8,101,000
Pumped Pressure	ac.	9,300	7,784,000
TOTAL COST	$		23,322,000

Level of Federal Funding

Federal cost-share rates to implement the recommended plan should be not greater than 75 percent. This 75 percent cost-share rate requires $23,325,000 in federal funds over the six year period, consisting of $17,490,000 cost-share assistance for construction, $5,835,000 for administrative and technical assistance.

Annual levels of funding and total cost for the six-year installation period are shown in Table VI-2.

TABLE VI-2 ANNUAL LEVELS OF FUNDING NEEDED FOR IMPLEMENTATION. McELMO CREEK SALINITY CONTROL STUDY, COLORADO

Year	Construction Federal	Construction Local	Admin. & Technical Assistance 1/	Local O&M 2/	Total Federal	Total Local	Total Cost
	-------	------	-----------	---$1,000	--------	---------	----
1	2,915	972	972	30.7	3,887	1,002.7	4,889.7
2	2,915	972	972	61.4	3,887	1,033.4	4,920.4
3	2,915	972	972	92.1	3,887	1,064.1	4,951.1
4	2,915	972	973	122.8	3,888	1,094.8	4,982.8
5	2,915	972	973	153.5	3,888	1,125.5	5,013.5
6	2,915	972	973	184.2	3,888	1,156.2	5,044.2
TOTAL	17,490	5,832	5,835	644.7	23,325	6476.7	29,801.7

1/ Includes $295,000 annually to continue the following: $100,000 for an Irrigation Research Program by ARS, USDA; $45,000 for an Information and Education Program by ES, USDA: and $150,000 for Monitoring and Evaluating Results by SCS, USDA.

2/ Annual level of funding for O&M during implementation period. Following Implmentation Annual O&M Cost will remain at about $185,000.

Nondiscrimination

The salinity control program will be implemented in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964, as amended, and the regulations of the Secretary of Agriculture (7 CFR 15.1-1t.12), which provide that no person in the United States shall on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any activity receiving Federal financial assistance.

VII. IMPLEMENTATION AUTHORITIES

Section 201(c) of the Colorado River Basin Salinity Control Act (PL 93-320) directs the Secretary of Agriculture to cooperate and coordinate activities with other departments of federal government to carry out objectives of the Act. Section 203 authorizes preparation of planning reports on twelve salinity control units, including the McElmo Creek as a diffuse source control unit. However, the act contains no authority for implementing these reports.

This section discusses existing USDA authorities for implementation and makes recommendations for implementing the onfarm improvement program.

USDA Program Authorities

There are three primary USDA authorities through which onfarm improvements might be implemented. These are:

1. The Soil Conservation Act of 1935 (PL 74-46)

Under this authority the Soil Conservation Service was established to exercise powers conferred on the Secretary of Agriculture by the Act. Some of those powers are defined as authority to:

(1) conduct surveys, investigations, and research relating to the character of soil erosion and the preventive measures needed; to publish the results of any such surveys, investigations, or research; to disseminate information concerning such methods; and to conduct demonstrational projects in areas subject to erosion by wind or water;

(2) carry out preventive measures, including, but not limited to engineering operations, methods of cultivation, the growing of vegetation, and changes in use of land; and

(3) cooperate or enter into agreements with, or to furnish financial or other aid to any agency or any person, subject to such conditions as he may deem necessary.

With these authorities and working mainly through local soil conservation districts, the SCS helps individuals, groups, municipal and county officials, and planning bodies to cope with problems of erosion, water supply and disposal, improper land use, flooding, and sedimentation. Assistance rendered by SCS ranges from advice and consultation to on-site technical assistance for preparing conservation plans; determining where conservation practices are practical and necessary; designing, laying out, and supervising installation of the practices; and checking and certifying performance of the practices.

Through the Agricultural Stabilization and Conservation Service and the Agricultural Conservation Program the USDA shares with land users the cost of applying certain soil and water conservation measures that emphasize conservation benefits of national concern. These benefits include preserving, restoring and improving wetlands as

nesting and breeding areas for migratory waterfowl and achieving desirable adjustments in land use. Cost-sharing programs are administered by Agricultural Stabilization and Conservation committees at the state and county levels. County committees approve applications from local landowners for cost-sharing and authorize payments after conservation practices have been applied satisfactorily.

2. Federal Water Pollution Control Act (PL 92-500, as amended by Sec. 35 of the Clean Water Act -- PL 95-217)

The purpose of this authority is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Under authority of the Act the Rural Clean Water Program was designed to help control nonpoint sources of pollution. It is a voluntary program for applying best management practices on privately owned rural land in eligible project areas. Pollution control is to be achieved in the most cost-effective manner possible in keeping with producing adequate supplies of food and fiber and maintaining a quality environment.

Landowners may apply for cost-share assistance until September 30, 1988. Financial assistance is provided through long-term contracts (5 to 10 years) to install best management practices in areas having critical water quality problems resulting from agricultural activities. Landowners can receive up to 50 percent of the cost of applying Best Management Practices. This amount may be increased when it is determined there are significant off-site public benefits and if a lower cost-share rate places a burden on the participant that would prevent participation in the program. Maximum federal cost-share per participant is $50,000. Once a contract is approved the full amount of cost-share funds are set aside for completion of the contract.

Landowners and operators in approved project areas who develop and submit an acceptable water quality plan for their farm or ranch to the Soil Conservation District and sign a contract with the administering agency become eligible to participate in the program. Assistance to develop the Water Quality Plan is available from the Soil Conservation Service through Soil Conservation Districts, and from others.

The State Soil Conservation Agency, State Water Quality Agency, or Soil Conservation Districts administer Rural Clean Water Projects when practical. The USDA will administer the program when one of these is not designated. The SCS, having program leadership for USDA, transfers funds to the Agricultural Stabilization and Conservation Service for partial administration of the program.

3. The Watershed Protection and Flood Prevention Act (PL 566 - 83rd Congress)

Under this authority USDA has a permanent program by which technical and financial assistance can be given to local watershed groups willing to assume responsibility for initiating, carrying out, and sharing the costs of upstream watershed protection and flood control. Included in the Act are authorities to:

(1) conduct such investigations and surveys as may be necessary to prepare plans for works of improvement;

(2) prepare plans and estimates required for adequate engineering evaluation;

(3) make allocations of costs to the various purposes to show the basis of such allocations and to determine whether benefits exceed costs;

(4) cooperate and enter into agreements with and to furnish financial and other assistance to local organizations; provided, that, for land treatment measures, Federal assistance cannot exceed the rate of assistance for similar practices under existing national programs;

(5) obtain the cooperation and assistance of other Federal agencies in carrying out the purposes of the Act;

(6) enter into agreements with landowners for implementing changes in cropping systems and land uses and for installation of soil and water conservation practices and measures needed to conserve and develop soil, water, woodland, wildlife, and recreation resources.

The federal government provides technical help in planning and installing project measures, pays the full cost for building flood prevention measures, and shares the cost of other measures. Major obligations of local sponsors include acquiring land, easements, and rights-of-way; awarding contracts for construction on private land or electing to delegate contracting to SCS; sharing the construction cost of measures if appropriate; and operating and maintaining the project when completed.

Recommendations for Implementation

The implementation program needed to significantly reduce salt loading requires accelerated application of conservation practices under on-going USDA programs and the cooperative effort of federal, state and local agencies, and private organizations. To achieve full potential reduction, two conditions must be satisfied. First, recommended management practices must be followed to a high degree of precision; and, second, all of the recommended improvements in the irrigation system must be installed.

Nine actions have been identified as being essential to a successful implementation program. These are:

1. Authorize a continuing level of federal funding that provides incentive for voluntary and continued participation of the farm operators to achieve early completion of the recommended plan to reduce salinity.

2. Establish a local salinity control coordinating committee and follow implementation priorities established by that committee consistent with objectives of the Salinity Control Program so those areas contributing the highest salt load will be treated first.

3. Provide increased technical assistance by SCS through the Montezuma Soil Conservation District and by the ASCS county office to service the expected accelerated work load.

4. Develop a conservation plan for management of complete resource systems including an environmental evaluation for each farm. The conservation plan will identify conservation practices consistent with priorities established for salinity control and reflecting the owner's decisions for making improvements to meet his objectives consistent with those of the Salinity Control Program.

5. Structure the implementation program so that the off-farm group ditches receive improvement ahead of the farms served by those group ditches.

6. Obtain a long-term commitment from farm operators to begin an improvement program based on individual conservation plans and to accelerate that program consistent with established priorities for early completion of needed improvements.

7. Continue the program for irrigation research to determine applicability and limitations of various irrigation methods under local conditions of soil, climate, crops and economics.

8. Initiate a program to monitor and evalute effectiveness of onfarm improvements to verify that objectives of the salinity control program have been achieved.

9. Initiate an information and education program to disseminate results of research and new developments in irrigation equipment and practices that can aid farmers in practicing good water management for salinity control.

Level of Funding - The level of funding both public and private is a critical element affecting the implementation of works of improvement. Although the Colorado River Basin Salinity Control Act (P.L. 93-320) does not specify a period of time for completion of the salinity control program, it is recommended that implementation be completed within six years. In order to achieve that goal a long-term level of federal funding must be authorized such that each landowner will have the incentive to meet the remaining level of funding required throughout the implementation period. Also, the USDA's annual ACP funding limit per farmer should be increased so that extensive work can be done in concentrated areas in the shortest possible time.

Implementation Priorities - Water quality data shows variability in the magnitude of salt load pickup throughout the valley. The variability suggests priority rankings such that treatment will start in those areas where the greatest salt load reduction can be achieved first before moving on to the lessor salt yielding areas. Analysis of present salt loading suggests the following priorities for implementation.

Priority	Area
1	Irrigated land in the Mud Creek and Navajo Wash drainage areas.
2	Irrigated land in the McElmo Creek drainage east of the bridge at Highway 666.
3	Irrigated land in the Hartman Draw, Crow Creek, and Alkalai Creek drainage.

Increased Technical Assistance - Present assistance available to the Soil Conservation District includes one district conservationist, and four technicians. Additional expertise in planning, engineering, construction and biology will be needed. Current personnel ceilings must be increased if additional expertise is to be made available for the Salinity Control Program without eliminating or severely reducing the limited level of technical assistance elsewhere. The estimated additional cost for technical assistance annually to serve the accelerated salinity control program is given in Table VI-2.

Conservation Planning - Conservation planning will be based on managing complete resource systems, which when implemented results in the application of needed conservation practices on the land meeting the land treatment needs and objectives of the landuser. Soil, water, and related plant and animal resources must be considered in the planning process to guide deliberate actions that will result in conservation treatment, decisions, and actions. This continuing process includes inventory, assessment, evaluation of alternatives, decisions, implementation by landusers, and followup assistance to insure continued application of management practices and maintenance of applied practices.

Conservation planning will be done on an area wide basis to evaluate effects of both onfarm improved irrigation water management and off-farm delivery system improvements.

Impacts on salinity, downstream water quality, wildlife and wetland habitat, archeological, cultural and historic resources, prime and improtant farmlands, and erosion and sediment reduction will be evaluated in the planning process.

The irrigation water management plan is part of the continuing planning process and development of the conservation plan. Consideration needs to be given for possible changes in the conservation cropping system that may result from better water management. Changes in cropping system may include greater diversity of crops than were previously grown due to increased duration of use, amount of available water, and length of season that water is available. Improved crop production and residues provide opportunity for higher levels of managment and economic returns to the landuser.

The irrigation water management plan will be developed with the landuser to determine and control the rate, amount and timing of irrigation water in a planned and efficient manner to prevent deep percolation and non-uniform application of irrigation water; and also to plan the efficient layout of fields and irrigation systems to enable efficient application of water, reduce saline return flows, and meet the needs of the landuser.

Conservation planning will consist of reviewing alternatives and the environmental concerns with the landuser and recording his decisions regarding the type and extent of conservation practices to be installed, the schedule for installation, and his agreement to implement the conservation plan.

During the conservation planning phase SCS technicians will strive to identify and make provisions for detailed survey, recovery, protection or preservation of unique cultural resources that otherwise might be irrevocably lost or destroyed by implementing salinity control practices. During the implementation phase landowners will be encouraged to cooperate with the State Historic Preservation Officer if evidence is found that archaelogical or cultural materials may be present, so that the materials can be evaluated and important items salvaged.

Commitment by each Farm Operator - Long term contracting is recommended as the way to assure the farm operator of a continued federal commitment and secure his cooperation for implementation. The Great Plains Conservation Program, the Welton-Mohawk Salinity Control Program in Arizona, and the long-term agreements (LTA's) under ACP provide patterns for administering long-term contracts. Although the authority for GPCP and Welton-Mohawk does not specifically apply, contracting procedures from either program can be readily adapted to the Salinity Control Program.

Program for Irrigation Research - Studies in the area indicate that canal, lateral, and on-farm ditch seepage and deep percolation are all significant sources of salt loading in the Colorado River. The systems improvement program by the Bureau of Reclamation will greatly reduce canal seepage. Improvements in existing surface irrigation methods, as described in this report, will improve efficiency of water use onfarm. Future research must be directed toward development and evaluation of onfarm irrigation systems that will further decrease deep percolation and reduce surface runoff. New systems should be low cost and have low requirements for labor and new energy if they are to be widely adopted. Because of poor drainage and high salt content of most soils in the area, irrigation systems should allow for uniform and closely controlled leaching.

Irrigation systems meeting the above requirements include sprinkler systems with appropriate low pressure nozzles, multi-set sprinklers and tailwater reuse. Future irrigation research should be directed toward determining the applicability and limitations of such systems under local soil, climate, crop and economic conditions. Reductions in deep percolation, salt leaching, surface runoff and erosion should be documented for each system, relative to current practices. Design criteria should be developed or refined for local conditions. Finally, those systems that appear to be practical should be demonstrated to promote local acceptance. The estimated cost for continuing the research program conducted by the Agriculture Research Service is included in Table VI-2.

Program for Monitoring and Evaluating Results - Typical farms in sample areas of the valley need to be selected for monitoring in cooperation with the farm operator. Technical assistance and appropriate equipment will be needed. Automated controls for the irrigation system and improved irrigation methods need to be demonstrated to enhance acceptability among local farm operators. Streamflow size and duration of irrigation should be measured to verify adherence to the recommended program for improvement. The depth of water penetration and volume of water stored in the root zone should be measured to determine effectiveness of the improvement program. Effects of the Salinity Control Program also should be monitored at local gaging stations operated by the U.S. Geologic Survey under ongoing programs. The estimated cost for a Monitoring and Evaluation Program is included in Table VI-2.

Program for Information and Education - A program to disseminate the results of research and new developments in irrigation equipment and practices will be needed. This program should include a full spectrum of information activities ranging from newspaper articles to farm demonstrations. The goal of the information program is to assist irrigaters in practicing proper irrigation water management. Other work needed includes organizing small groups of landowners so that they can effectively improve and maintain the laterals.

One positions should be established to work in this area during the installation period. The estimated cost for this assistance is included in Table VI-2.

Table Al-1
National Economic Development Account 1/
McElmo Creek Salinity Control Study, Colorado
($1,000 increments)

		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
A. Beneficial Effects							
1. Value of Goods and Services							
a. Onfarm Benefits	($)	15.4	342.2	415.7	905.6	1075.6	142.3
b. Downstream Benefits	($)	102.0	663.0	1224.0	1887.0	1938.0	1071.0
c. Benefits during installation period	($)	27.7	237.3	387.1	659.3	711.5	286.4
Total Beneficial Effects	($)	145.1	1242.5	2026.8	3451.9	3725.1	1499.7
B. Adverse Effects							
1. Implementation Costs							
a. Project Installation	($)	78.6	456.6	1116.4	2148.8	2305.7	1604.5
b. Project Administration	($)	7.9	46.1	112.7	216.9	232.7	161.9
c. Operation, Maintenance & Replacement	($)	3.0	200.0	220.3	204.7	184.3	40.3
d. Cost during installation period 2/	($)	19.1	156.4	314.8	550.9	582.2	383.1
Subtotal Implementation Costs 3/	($)	108.6	859.1	1764.2	3121.3	3304.9	2189.9
C. Net Beneficial Effects	($)	36.5	383.4	262.6	330.6	420.2	-690.2

1/ Costs were amortized at 7 5/8% for 25 years. July 1981 price base. Benefits and costs were computed in present value terms using 6-year installation period. Water Resources Council (WRC) fiscal year 1982 crop prices were used.
2/ Includes interest on O&M and construction costs O&M cost during installation period.
3/ No mitigation, archeological, or land rights costs are anticipated.

Table A1-2
Regional Development Account 1/
McElmo Creek Salinity Control Study, Colorado
($1,000 increments)

		Plan 1		Plan 2	
		State of Colorado	Rest of Nation	State of Colorado	Rest of Nation
I. Income					
A. Beneficial Effects					
1. Value of Goods and Services					
a. Onfarm Benefits	($)	15.4	—	342.2	—
b. Downstream Benefits	($)	—	102.0	—	663.0
c. Construction Labor	($)	6.2	—	35.9	—
d. Benefits during installation period	($)	3.6	24.1	80.8	156.5
2. Value of External Economies	($)	26.9	—	599.9	—
Total Beneficial Effects	($)	52.1	126.1	1058.8	819.5
B. Adverse Effects					
1. Implementation Costs					
a. Project Installation 4/	($)	18.0	60.6	104.7	351.9
b. Project Administration	($)	—	7.9	—	46.1
c. Operation, Maintenance & Replacement	($)	3.0	—	200.0	—
d. Costs during installation period 5/	($)	4.5	14.6	72.4	84.0
Total Adverse Effects 6/	($)	25.5	83.1	377.1	482.0
C. Net Beneficial Effects	($)	26.6	43.0	681.7	337.5
II. Employment					
A. Beneficial Effects					
1. Increase in Jobs					
a. Semi-skilled 2/		0.4	—	2.2	—
b. Unskilled 2/		4.1	—	23.7	—
c. Agricultural 3/		—	—	—	—
2. Decrease in Jobs					
a. Agricultural 3/		—	—	—	—

1/ Costs were amortized at 7 5/8% for 25 years. July 1981 price base. Costs and benefits were computed in present value terms using 6-year installation period. Fiscal Year 1982 WRC crop prices used.

2/ Work years.

3/ Work year/year.

4/ Based on 75 percent federal cost share for construction costs.

5/ Includes interest on O&M and construction cost and O&M costs during installation period.

6/ No mitigation, archeological, or land rights costs are anticipated.

Table A1-2
Regional Development Account 1/
McElmo Creek Salinity Control Study, Colorado
($1,000 increments)

		Plan 3		Plan 4	
		State of Colorado	Rest of Nation	State of Colorado	Rest of Nation
I. Income					
A. Beneficial Effects					
1. Value of Goods and Services					
a. Onfarm Benefits	($)	415.7	—	905.6	—
b. Downstream Benefits	($)	—	1224.0	—	1887.0
c. Construction Labor	($)	87.8	—	168.9	—
d. Benefits during installation period	($)	98.1	289.0	213.8	445.5
2. Value of External Economies	($)	728.7	—	1587.5	—
Total Beneficial Effects	($)	1330.3	1513.0	2875.8	2332.5
B. Adverse Effects					
1. Implementation Costs					
a. Project Installation4/	($)	256.0	860.3	492.8	1656.0
b. Project Administration	($)	—	112.7	—	216.9
c. Operation, Maintenance & Replacement	($) e	220.3	—	204.7	—
d. Costs during installation period5/	($)	109.5	205.4	155.5	395.4
Total Adverse Effects 6/	($)	585.8	1178.4	853.0	2268.3
C. Net Beneficial Effects	($)	744.5	334.6	2022.8	64.2
II. Employment					
A. Beneficial Effects					
1. Increase in Jobs					
a. Semi-skilled2/		5.4	—	10.3	—
b. Unskilled2/		58.1	—	111.7	—
c. Agricultural3/		—	—	—	—
2. Decrease in Jobs					
a. Agricultural3/		1.1	—	17.2	—

1/ Costs were amortized at 7 5/8% for 25 years. July 1981 price base. Costs and benefits were computed in present value terms using 6-year installation period. Fiscal Year 1982 WRC crop prices used.
2/ Work years.
3/ Work year/year.
4/ Based on 75 percent federal cost share for construction costs.
5/ Includes interest on O&M and construction cost and O&M costs during installation period.
6/ No mitigation, archeological, or land rights costs are anticipated.

Table A1-2
Regional Development Account 1/
McElmo Creek Salinity Control Study, Colorado
($1,000 increments)

		Plan 5 State of Colorado	Plan 5 Rest of Nation	Plan 6 State of Colorado	Plan 6 Rest of Nation
I. Income					
A. Beneficial Effects					
1. Value of Goods and Services					
a. Onfarm Benefits	($)	1075.6	—	142.3	—
b. Downstream Benefits	($)	—	1938.0	—	1071.0
c. Construction Labor	($)	181.2	—	126.1	—
d. Benefits during installation period	($)	253.9	457.6	33.6	252.8
2. Value of External Economies	($)	1885.6	—	249.4	—
Total Beneficial Effects	($)	3396.3	2395.6	551.4	1323.8
B. Adverse Effects					
1. Implementation Costs					
a. Project Installation4/	($)	528.8	1776.9	368.0	1236.5
b. Project Administration	($)	—	232.7	—	161.9
c. Operation, Maintenance & Replacement	($)	184.3	—	40.3	—
d. Costs during installation period5/	($)	157.9	424.3	87.8	295.3
Total Adverse Effects 6/	($)	871.0	2433.9	496.1	1693.7
C. Net Beneficial Effects	($)	2525.3	- 38.3	55.3	- 369.9
II. Employment					
A. Beneficial Effects					
1. Increase in Jobs					
a. Semi-skilled2/		11.1	—	7.3	—
b. Unskilled2/		119.9	—	78.6	—
c. Agricultural3/		—	—	—	—
2. Decrease in Jobs					
a. Agricultural3/		32.6	—	—	—

1/ Costs were amortized at 7 5/8% for 25 years. July 1981 price base. Costs and benefits were computed in present value terms using 6-year installation period. Fiscal Year 1982 WRC crop prices used.
2/ Work years.
3/ Work year/year.
4/ Based on 75 percent federal cost share for construction costs.
5/ Includes interest on O&M and construction cost and O&M costs during installation period.
6/ No mitigation, archeological or land rights costs are anticipated.

Table A1-3
Other Social Effects Account 1/
McElmo Creek Salinity Control Study, Colorado

		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
A. Real Income Distribution							
1. Regional Farm Benefits2/	($)	19.0	423.0	513.8	1119.4	1329.5	175.9
2. Regional Farm Expense2/	($)	25.5	377.1	585.8	853.0	871.0	496.1
3. Distribution by Class							
a. Adj. Gross Farm Income3/ Benefits and Expenses							
Under $2,500	(%)	29	29	29	29	29	29
$2,500 - $10,000	(%)	36	36	36	36	36	36
10,000 - 20,000	(%)	14	14	14	14	14	14
Over $20,000	(%)	21	21	21	21	21	21
B. Life, Health and Safety	yes/no	No	Yes	Yes	Yes	Yes	Yes
1. Significant reduce salt content in water used by more than 17 1/2 million downstream residents in Colorado, Utah California, Arizona, Nevada and the Republic of Mexico.							
2. Significant Increase the assessed valuation of property and tax revenues from farms and farm related business due to the project.		No	No	No	Yes	Yes	No
3. Increased output and long term stabilizing influence on agricultural population and out-migration.		No	No	No	Yes	Yes	No
4. Installation of irrigation measures will result in higher crop yields, and more efficient use of irrigation water and more efficient fertilizer use.		No	Yes	Yes	Yes	Yes	No
5. Installation will result in significant lower costs in labor.		No	No	No	Yes	Yes	No
6. Energy consumption in trillions of BTU's.		0.050	0.291	0.711	1.369	1.469	1.022

1/ Cost were amortized at 7 5/8 for 25 years. July 1981 price base. Benefits and costs were computed in present value terms with a 6-year installation period. Fiscal Year 1982 WRC crop prices used.
2/ Increments of $1,000
3/ Census of Agriculture (1978)

Table A1-4
Envirionmental Quality Account
McElmo Creek Salinity Control Study, Colorado

	Alternative Plan Number					
	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
A. Irrigated Area Treated (ac)	29,100	20,900	21,550	21,050	21,550	28,450
B. Water Quantity (ac.ft./yr)						
1. Diversion 1/	121,000	90,000	84,000	85,000	85,000	114,000
2. Change in Diversion	0	37,000	37,000	36,000	36,000	7,000
3. Delivered to Farms	118,000	87,000	84,000	85,000	85,000	114,000
4. Onfarm Deep Percolation	10,000	7,000	7,000	7,000	7,000	10,000
5. Consuptive Use (Onfarm) 2/	54,000	54,000	54,000	54,000	54,000	54,000
6. Consumptive Use (Wetland) 2/						
7. Reduction in Consumptive Use						
8. Return Flow						
9. Onfarm Irrig. Efficiency Valleywide Effect	45%	60%	64%	64%	64%	47%
C. Water Quality						
1. Reduction in Salt Loading (tons) 3/	-6,000	17,000	18,000	31,000	32,000	21,000
2. Reduction in Salt Concentrations at Imperial Dam (mg/1)	-3.1	0.8	2.1	3.4	3.6	1.1
3. Salt Concentrations Upstream from Parker Dam.	830	827	826	825	824	827
D. Wetlands						
1. Area of Wetlands in treatment area (ac)	11,000	7,900	8,100	8,000	8,100	10,800
2. Impacts						
a. Area (ac)	1,850	1,725	1,750	1,725	1,750	1,800
b. Values (HUV) 4/	10,100	9,420	9,555	9,420	9,555	9,830
3. Avoided Impacts						
a. Area (ac)	9,165	6,175	6,395	6,230	6,395	8,955
b. Values (HUV) 4/	49,500	33,300	34,500	33,600	34,500	48,300
4. Wetlands Lost (ac per 1,000 tons)	—	133	73	47	46	67
F. Historical and Archeological						
1. Sites listed in National Register 4/ 5/	0	0	0	0	0	0
2. Area avoided (ac) 5/ 6/	0	8,200	7,550	8,050	7,550	650

1/ Based on volume of water deliverd at the farm to irrigate the 29,100 acres in the valley.
2/ Present consumptive use on 29,100 acres of irrigated cropland is 47,000 acre-feet per year.
3/ Based on 28,450 acres of improved irrigated land remaining after program implementation.
4/ HUV = Habitat Units Value after USFS Habitat Evaluation Procedure (HEP).
5/ Should sites of archeological value be discovered during construction, work will be stopped to give the State Historic Preservation Officer time to assess the value of the site and salvage valuable artifacts.